PRELIMINARY REPORT ON THE STRESS TESTS CARRIED OUT BY THE SPANISH NUCLEAR POWER PLANTS

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1. INTRODUCTION

1.1 STRESS TESTS ADOPTED IN THE EUROPEAN CONTEXT

In the wake of the accident that occurred on March 11th at Fukushima nuclear power plant in Japan, each of the European countries initiated actions aimed at verifying the safety measures in place at their plants; however, the advisability of developing a coordinated response within the European Union very quickly emerged, in order to ensure that all the nuclear power plants in these countries were sufficiently robust to address situations similar to those that occurred at Fukushima.

In its meeting of March 24th 2011, the European Council agreed on a plan to subject all the European nuclear power plants to a homogeneous set of "stress tests" making it possible to assess their capacity to withstand situations beyond their respective Design Bases and identify the safety margins existing with respect to these bases, and the potential measures that might be implemented to improve their safety.

During a meeting held in Brussels on April 15th, with the participation of the EU, the regulatory bodies of the EU countries and industry representatives agreed that ENSREG, with technical support provided by WENRA, should draw up a proposal developing the technical content of the stress tests and define a method for their performance.

The proposal drawn up by WENRA was approved by ENSREG during its meeting of May 12th and submitted to the European Union, being finally approved by the Commission on May 25th and subsequently submitted to the European Council during its meeting of June 10th.

The Spanish Nuclear Safety Council (CSN) has actively participated at various levels in the discussion and drawing up of these documents, within the framework of both WENRA and ENSREG.

The document finally approved at European Union level defines the nuclear power plant Stress Tests as a complementary reassessment of the safety margins of these facilities in the light of the events that took place at Fukushima; in other words, considering extreme natural phenomena that might jeopardise the safety functions of the installations and possibly lead eventually to an accident situation entailing damage to the fuel (severe accident).

As set out in the aforementioned document, these analyses are to be carried out for each site by the licensees of the facilities. The review of the analyses must be performed completely independently by the regulatory authorities of each country, with the results consolidated in a national report. Finally, the entire process shall be subjected to a review carried out among all the regulatory bodies (Peer Review), with EU participation. The results of these reviews will be published and discussed at public seminars at national and international level, to which shall be invited stakeholders from different areas, such as the regulatory bodies, the licensees of the facilities and other representatives of the industry, non-governmental organisations, etc.

In keeping with the objectives mapped out by the European Council, the document reflects the following schedule: the licensee progress reports are to be submitted to the regulatory authority of each country by August 15th, and the final report containing the analyses performed and proposals for improvement identified throughout the process by October 31st.

By September 15th the regulatory bodies must submit their respective national progress reports, and by December 31st their final reports, with a summary of the analyses and conclusions of the licensees and the assessment of the regulator. Finally, the Peer Reviews will be carried out between January and April 2012.

1.2 ACTIONS UNDERTAKEN IN SPAIN

In response to the aforementioned accident, the Spanish Nuclear Safety Council (CSN) immediately initiated a process of gathering all the available information on its evolution, with two objectives: analysis of possible lessons to be learned from the accident and the supply of information to the Spanish public.

The Spanish nuclear power plants implemented a series of verifications and reviews to ensure that all existing measures to address design basis and beyond design basis events were operable, in accordance with the recommendations of WANO (*World Association of Nuclear Operators*). On March 25th, the CSN sent a letter to the licensees of the nuclear power plants requiring measures complementary to those initially implemented.

On May 25th, the CSN approved and sent to all the nuclear power plants a series of Complementary Technical Instructions (ITC) relating to their Operating Permits, requiring the performance of the stress tests agreed to within the context of the European Union. The report containing the results must include a detailed proposal of the planned measures and their scheduling.

In addition, and in accordance with the scope proposed at European level, the CSN sent a similar ITC to the José Cabrera nuclear power plant, which is currently in the dismantling process and where spent nuclear fuel is kept on site. The content of this particular CTI is an adaptation of the general stress test programme to the specific circumstances and risks of the plant in question.

Finally, and although outside the framework established at European level, the CSN also sent a ITC to the licensee of the nuclear fuel manufacturing facility existing in Spain requiring the performance of tests specifically adapted to the design of that installation.

2. WORKING METHOD

This report has been drawn up with the objective of documenting the assessment performed to date by the CSN of the information submitted by the licensees of the Spanish nuclear power plants in their progress reports on performance of the so-called "Stress Tests" established at European level. These tests consist essentially of a reassessment of the safety margins of the nuclear power plants in the light of the events that took place on March 11th 2011 at Fukushima nuclear power plant in Japan.

This initial report drawn up by the CSN and those submitted by the licensees (Progress Reports) are preliminary in nature, since it has not been possible to complete all the analyses and reviews in the time available. Nevertheless, the general approach followed has consisted of attempting to cover all the aspects to be analysed, identifying those that remain pending. In this way it has already been possible to identify many of the robustness's of the Spanish plants with respect to the scenarios analysed and the improvements to be implemented in order to strengthen the response capability. In any case, the conclusions of these reports will need to be confirmed in the final reports.

In accordance with the requirements, the licensees were to analyse for each site the current capabilities of the facility to respond to the following events:

- External events: earthquakes, flooding and other natural events.
- Loss of safety functions due to loss of the different stages of electricity supply and of the ultimate heat sink.
- Management of severe accidents affecting the reactor core and loss of spent fuel pool inventory and/or cooling accidents.

In the event of there being any other type of storage arrangement for spent fuel on the site, an analysis should be made of its robustness with respect to off-site events and loss of the aforementioned functions.

With a view to harmonising the analyses to be performed by the Spanish plants and establishing the contents of the reports to be drawn up, various coordination meetings were held in June and July between the CSN and the licensees, along with internal meetings among the latter, during which technical aspects relating to the scope and method for performance of the required analyses were dealt with. Likewise, two joint meetings were held with the plant licensees and the operator of the Spanish electricity grid (REE) to review actuations and protocols in relation to the reliability of the grid and the capability of recovering electricity supply in the scenarios contemplated in the stress tests.

Described below are the methods used by both the licensees and the CSN in drawing up their respective preliminary reports.

<u>PROCESS ADHERED TO BY LICENSEES</u>

The analyses performed by the licensees are being undertaken as described below:

- Verification of design basis compliance by the facility as regards aspects included in the scope of the stress tests, assessing the suitability of the design bases in the light of currently available technical know-how.

- Evaluation of the response of each facility to a series of extreme situations beyond the design basis, attempting to assess the available safety margins and identify those limit or cliff edge situations that might lead to extreme accident sequences and the response expected from the facility.

- Verification of the existence of adequate preventive and mitigation measures and, where necessary, proposals for the incorporation of improvements appropriate for the situations identified.

For each of the events proposed, an analysis is being performed of the current capabilities of each plant to respond to them, as regards both design and organisation, and attempts must be made to identify the autonomy (time intervals available) to address the loss of safety functions and the resources required to prevent a serious accident from having unacceptable consequences for the population.

These evaluations are being carried out in accordance with the philosophy of *defence in depth,* proposed in the ENSREG document, for the set of situations proposed in that document, a deterministic approach being used in which the sequential loss of the existing lines of defence is assumed, regardless of their probability of occurrence.

The ultimate objective established by the licensees in their reports is to confirm the degree of robustness of the plants when faced with the situations proposed, and the suitability of the existing measures for accident management and, finally, to identify potential applicable improvements as regards both equipment (fixed and portable) and organisation: procedures, human resources, emergency response organisation and use of off-site resources.

The documentation used for the performance of these analyses has been that included in the plant Safety Analysis Report, Technical Specifications, Site Emergency Plan, operating procedures, including the emergency operating procedures, severe accident management guidelines, probabilistic safety assessments and other design documentation, as well as specific studies carried out especially for these stress tests.

The licensees have also carried out specific checks at their plants and inspections and tests to verify the capabilities reflected in their reports.

PROCESS ADHERED TO BY THE CSN

The CSN is a regulatory body that is equipped with its own technical staff. The assessments of the stress tests submitted by the licensees are being addressed internally, without the need to call on any technical support from outside, although there has been collaboration in certain areas by the operator of the Spanish electricity grid (REE), as pointed out above, and by the Centre for Public Works Studies and Experimentation (CEDEX), a public organisation of recognised solvency reporting to the Ministry of Public Works, that has participated by evaluating issues relating to external flooding. In this last case, the advisory services rendered have focussed on the analyses submitted by the licensees of the resistance of dams located upstream in the river basins in which the facilities are located and of their consequences in terms of flooding of the areas around the sites.

In order to systematise the assessment process, the CSN has issued a specific assessment guideline detailing the methodology to be applied, the organisational units responsible for each part of the process, the interactions between them and the schedule outlined. Furthermore, in view of the limits regarding available time, weekly coordination meetings have been held during which the preliminary conclusions drawn by the different organisational units have been discussed.

The CSN assessment has consisted of a review of the documentation submitted by the licensees, focussing on the following aspects:

- Verification of the completeness of the analyses submitted by the licensees with respect to the scope required, differentiating those aspects for which the foreseen studies have been completed and the improvements actions described from others still pending or in the performance phase. Also identified are those others that are not mentioned in the reports of the licensees and that are to be studied. The objective of all the above being to guarantee that the final reports of the licensees are complete and reasonably homogeneous.
- Verification that the analyses have been performed in a coherent and systematic manner, with a view to identifying and establishing the significance of potential weaknesses or opportunities for improvement.
- Evaluation of the hypotheses and analytical methods used by the licensees in their reports, checking their suitability with respect to the scope and foreseen contents of the stress tests.
- Verification that, for all the aspects analysed, the licensees' reports have contemplated possible cliff edge situations. The situations considered applicable for this verification shall be those that, although having a very low probability of occurrence, cannot be considered impossible.
- Verification that, for all the aspects analysed and in keeping with the results of the analyses, the reports analyse the advisability or need to reinforce the existing design and organisation-related capabilities, checking that a reasoned justification of the conclusions drawn is provided.
- Evaluation of the feasibility and reliability of the recovery and mitigation actions referenced in the licensees' reports. When applicable, this implies the possible performance of specific tests and the drawing up of written procedures for this purpose.

The information submitted has been contrasted with the licensing documentation and other information available at the CSN, as well as with the results of inspections performed in the past. In view of the schedule established for the preparation of these reports, it has not yet been possible to review the licensees' new calculations in detail or perform specific inspections to check the contents of the reports. These reviews and checks will be carried out, to the extent possible, prior to the issuing of the final report.

Furthermore, the detailed design and the implementation of the improvements identified in the report, along with whatever other measures might be derived from the lessons learned from the Fukushima accident, will be carried out within the framework of a short to medium-term planning that will be closely tracked by the CSN and that will require the performance of new inspections and evaluations.

3. GENERAL DATA ON THE FACILITIES AND PSA RESULTS

As is reflected below, the Spanish operating nuclear fleet currently comprises 6 sites and a total 8 units. There is also a site at which the plant is currently in the dismantling process and which has a temporary spent fuel storage facility:

- Trillo Nuclear Power Plant (KWU 3 loops).
- Vandellós II Nuclear Power Plant (Westinghouse 3 loops).
- Cofrentes Nuclear Power Plant (GE-BWR6).
- Ascó Nuclear Power Plant (Westinghouse 3 loops, 2 units).
- Almaraz Nuclear Power Plant (Westinghouse 3 loops, 2 units).
- Santa María de Garoña Nuclear Power Plant (GE-BWR3).
- José Cabrera Nuclear Power Plant, in the dismantling phase (Westinghouse 1 loop).

This section includes a general description of each of these facilities, along with a summary of the main numerical results obtained from the probabilistic safety assessments performed.

3.1. TRILLO NPP

Trillo nuclear power plant is owned by the companies Iberdrola Generación S.A.U., Gas Natural SDG, S.A., Hidroeléctrica del Cantábrico, S.A. and Nuclenor, S.A.

a) Site

Trillo Nuclear Power Plant is located in the area known as "Cerrillo Alto" in the municipality of Trillo (Guadalajara), on the right bank of the river Tajo. The site is 93 km from Madrid as the crow flies and 47 km from Guadalajara, and is located East/Northeast with respect to these two cities. The esplanade on which the plant is built is 835 metres above sea level and is approximately 300 km from the coast.

b) Description of the unit

A single three-loop pressurised water reactor (PWR) operates at the site, this having a nominal thermal power level of 3,027.0 MWt, corresponding to a reactor power of 3,010.0 MWt. The reactor was designed and supplied by the German company Kraftwerk Union Aktiengesellschaft (KWU). At present the “main vendor” is the French company AREVA. The reactor first reached criticality on May 14th 1988.

- Reactor Coolant System

The Reactor Coolant System is made up of the pressure vessel, housing the reactor core, and three cooling loops, each of which is equipped with a Coolant Pump and a Steam Generator. One of the loops incorporates the Pressurizer in its hot leg.

- Engineered Safeguards

The main engineered safeguards are as follows:

- Emergency Core Cooling System.
- Containment Isolation System.

The safeguards systems are basically made up of four redundant trains, two of which are sufficient to carry out the safety function assigned, and are designed as Seismic Category I systems, capable of withstanding the loads of the Design Basis Earthquake (SSE: Safe Shutdown Earthquake). These systems are housed in Seismic Category I structures that protect them against the external events postulated for the site.

The Emergency Core Cooling System (ECCS) comprises a medium pressure injection system (110 bar), a passive system (6 accumulators) injecting at medium pressure (25 bar) and a low pressure injection system. These systems guarantee the integrity of the fuel in the event of the postulated Loss of Coolant Accident (LOCA). The actuation of the ECCS, and of the containment isolation system that causes the fluid transport lines penetrating the containment to be closed, also guarantees that the established dose limits are not exceeded.

The source of borated water for the active emergency cooling systems is the 4 Borated Water Tanks (BWT), one per redundancy.

Although it is not a safeguards system in the strictest sense, the plant also has an Emergency Feedwater System with 4 trains, each equipped with a diesel generator and a pump, which allow water to be injected into the Steam Generators and provide electrical supply for all the associated loads. The system has independent sources of water.

- Electrical supply systems

For internal plant consumption, Trillo NPP has the following supplies: the main 400 kV grid, which continues to be available following generator trip thanks to the opening of the "generation breaker", the main generator for in-house consumption ("island" mode of operation) and feed from the 220 kV back-up grid in the event of failure of the two previous sources.

In addition to the above, there is another source for the safeguards and emergency networks from a third 132 kV off-site grid, independent from the 400 kV and 220 kV feeds and capable of maintaining and taking the plant to safe conditions.

In the event of loss of off-site power (LOOP), the supply for the internal safeguards and emergency networks is provided by the automatic start-up of the four (4) Safeguards Diesel Generators. There are also procedures contemplating the start-up of the Bolarque, Buendía and Entrepeñas hydroelectric stations.

In the event of complete loss of alternating current (SBO: Station Blackout), i.e. the loss of both the off-site sources and the aforementioned Diesel Generators, there are four (4) Emergency Diesel Generators to maintain electrical supply for the safety-related equipment if necessary.

Both the Safeguards Diesel Generators and the Emergency Diesel Generators are designed as Seismic Category I.

- Heat Sink

The plant has two heat sinks: the primary heat sink comprises two natural draught cooling towers that remove heat from the main condenser and a battery of forced draught towers that allow the thermal load of the auxiliary systems to be removed during normal operation. The alternative heat sink (Ultimate Heat Sink, UHS) is made up of two sub-systems, each of which consists of two batteries of forced draught cooling towers, 2 cooling water pumping and distribution sub-systems and a water storage pool. Each of these pools provides an autonomy for 30 days. This sink is designed as Seismic Category I and, like the entire site, is protected against possible flooding by the river Tajo due to its being located on a level high above the normal level of the river.

- Containment Building

This building, which is of the Large Dry Containment type, has a free volume of almost 60,000 m^3. The building is formed by a self-supporting steel sphere surrounded by a reinforced concrete structure, forming a double containment. The foundation slab is of reinforced concrete and incorporates a cavity for the reactor vessel.

The design pressure and temperature of the Containment Building are 5.38 bar_{rel} and 145ºC. The analyses performed within the framework of the Level 2 PSA have determined that the ultimate capacity of the Containment Building is 7.55 bar_{rel}.

- Spent Fuel Storage

The plant stores its spent fuel in two locations: the spent fuel pool, located inside the Containment Building, and an Individualised Temporary Storage facility for Spent Fuel Casks which is inside the area under the control of the licensee.

- Spent fuel pool

The walls of the pool are made of reinforced concrete supporting a stainless steel liner. The pool has a storage capacity for 628 fuel assemblies, maintaining an additional capacity equivalent to a complete core (177 fuel assemblies). The storage racks are compact in design and have channels of borated steel. The design of the pool guarantees an effective constant of multiplication of no more than 0.95, as long as there is a given concentration of boron in the pool water, this being considerably lower than that required by the Operating Specifications (2,550 ppm).

- Temporary storage facility

The Individualised Temporary Storage facility for Spent Fuel Casks belongs to the plant, as does the spent fuel, although the casks housing this fuel are the property of the Empresa Nacional de Residuos Radiactivos (ENRESA), Spanish radioactive waste management company. When the casks are transferred to the future Centralised Temporary Storage (CTS) facility, the spent fuel they contain will become the property of ENRESA.

The plant temporary storage facility has been designed for a capacity of 80 casks, which are housed in a building designed to seismic category I. The passive design of the cask and of the building ensures the removal of the residual heat generated by natural convection under the storage conditions contemplated.

- Significant safety-related differences between groups

Not applicable.

c) Scope and summary of results of Probabilistic Safety Assessment

In accordance with the requirements established by the CSN, the plant has the PSA models indicated below. These models are updated periodically and have in fact recently undergone an update as part of the process of renewing the operating permit of the facility.

- Level 1 PSA of On-site Events at Power.
- Level 1 PSA of On-site Events in Other Operating Modes
- Level 1 PSA of On-site Flooding at Power.
- Level 1 PSA of On-site Fires at Power.
- Level 2 PSA of On-site Events at Power.
- PSA of Other Off-site Events.
- PSA of Fuel Pool with group shut down

Level 1 PSA of On-site Events at Power: the core damage frequency obtained is 2.51E-06 / year, the initiating events making the highest contribution being generic transients (43%), loss of auxiliary electricity supply or LOOP (20%) and LOCAs (30%).

Level 1 PSA of On-site Events in Other Operating Modes: the core damage frequency obtained is 1.43E-05 / year, the initiating events making the highest contribution being loss of auxiliary electricity supply with the primary system at 3/4 loop open (37.92%) and closed (19.48%), Residual Heat Removal (RHR) rupturing or leakage with the cavity full (13.83%) and rupturing or leakage outside containment with the Reactor Coolant System (RCS) at 3/4 loop open (11.37%).

Level 1 PSA of On-site Flooding at Power: the calculated value of core damage frequency due to on-site flooding is 1.18E-06/year, the most significant floods occurring in the turbine building (44.18%), the reactor building annulus and different areas of the electrical building, the majority resulting from breaks or cracks in the piping of the Fire Protection System (FPS).

Level 1 PSA of On-site Fires at Power: the value of core damage frequency obtained for the most significant events is for fires in the area of the main feedwater system pumps in the turbine building (2.82 E-06/year). In the electrical building the main contributor is the cable distribution room for the redundancy 3 power cabinets in building ZE (1.86 E-06 /year). Another important contributor (1.40E-06/y) would initiate as a result of "transient" fuel during the performance of work with a fire permit in the reactor building annulus.

Level 2 PSA of On-site Events at Power: the overall results obtained point to a frequency of major early releases from containment (MERC) of 1.91E-07/year and to a slightly higher frequency of off-site volatile emissions of more than 3% over a period of 24 hours as from initiation of the accident. The contribution to this frequency is governed fundamentally by Steam Generator Tube Rupture scenarios and, to a lesser extent, by scenarios entailing the dynamic pressurisation of the containment in the short and medium term, such as the rocket mode and detonations.

PSA of other off-site events: the results of this analysis indicate that the only event that might contribute to the risk of the facility would be an earthquake, this being analysed in detail in the corresponding chapter of this report.

PSA of Fuel Pool with the group shut down: the value obtained for the frequency of damage to the fuel assemblies stored in spent fuel pool is 1.60E-06 / year. The most important initiating events are loss of 400kV and 220kV electricity supply (69%) and loss of pool cooling as a result of residual heat removal systems failure (31%).

3.2 VANDELLÓS II NPP

The Vandellós II nuclear power plant belongs to the electricity utilities Endesa Generación SA (72%) and Iberdrola Generación S.A.U. (28%).

a) Site

The Plant is located on the Mediterranean coast in the province of Tarragona. The site is located on a strip of land between the A7 motorway and the sea, and is divided into two parts by the Valencia to Barcelona railway line and the N-340 highway.

The area has a Mediterranean climate and enjoys the mild weather that is typical of the north-eastern coast of the Iberian Peninsula, although in view of its proximity to the basin of the river Ebro, which constitutes a channel for the circulation of winds, it is affected by the latter.

There are no permanent water courses reaching the sea alongside the site, but rather small intermittent torrents that carry water only when storms occur.

b) Description of the unit

On the site there is a single Westinghouse design three-loop Pressurised Water Reactor (PWR) with a rated thermal power of 2,940.6 MWt.

The Plant performed its initial loading of fuel in August 1987. Initial criticality was achieved on November 13th 1987 and the declaration of commercial operation was issued on March 8th 1988.

- Reactor Coolant System

The Reactor Coolant System is made up of the pressure vessel, housing the reactor core, and three cooling loops, each of which is equipped with a Coolant Pump and a Steam Generator. One of the loops incorporates the Pressurizer in its hot leg.

- Engineered Safeguards

The main engineered safeguards are as follows:

- Emergency Core Cooling System.
- Containment Depressurisation and Heat Removal Systems (Spray and Cooling Units)
- Containment Isolation System.
- Containment Combustible Gases Control System.
- Auxiliary Feedwater System.
- Control Room Habitability Systems.

All the safeguards systems are basically made up of two redundant trains, each of which is capable of carrying out the safety function assigned, and are designed as Seismic Category I systems, capable of withstanding the loads of the Design Basis Earthquake (SSE: Safe Shutdown Earthquake). These systems are housed in Seismic Category I structures that protect them against the external events postulated for the site.

The Emergency Core Cooling System (ECCS) comprises a high pressure injection system, a passive system (3 accumulators) injecting at medium pressure and a low pressure injection system. These systems guarantee the integrity of the fuel in the event of the postulated Loss of Coolant Accident (LOCA). The actuation of the ECCS, and the containment safeguards systems (Containment Isolation, Spray System and Containment Cooling Units), guarantee that the established dose limits are not exceeded.

The source of borated water for the active emergency cooling systems is the Refuelling Water Storage Tank (RWST), the inventory of water of which amounts to 2,891 m^3 (High Level).

The objective of the Containment Safeguards Systems is to reduce pressure and temperature in the Containment Building following the occurrence of the design basis accidents: Loss Of Coolant Accident (LOCA) and Main Steam Line Break (MSLB), preventing the building design pressure and temperature from being reached and guaranteeing that the values reached will decrease to less than half in an interval of 24 hours. For its part, the Containment Isolation System causes the fluid transport lines penetrating the containment to be closed.

The Auxiliary Feedwater System is designed to inject water into the Steam Generators in response to any event causing the reactor to scram, allowing sensible and residual heat to be removed from the core. The system is equipped with two electrically operated pumps and a steam turbine driven pump. Each of the three pumps is capable by itself of providing the steam generators with the flow required to remove the residual heat from the reactor core. The preferential source of water for the system is the Condensate Tank (1,850 m^3). As an alternative, there is the auxiliary feedwater back-up tank with a capacity of 4,540 m^3.

For their operation the safeguards systems require support systems (cooling/power supply), also designed as Seismic Category I.

- Electrical supply systems

The plant is equipped with 3 independent off-site sources of electricity on three lines supplying power at 400 kV, 220 kV and 110 kV. The 400 kV feed is the preferential source for the auxiliary services of the Plant during normal operation and outages via the Group Transformer (TAU), which feeds all the class 1E and non-class 1E 6.25 kV busses by way of the grouped phase busses, to which the other 2 off-site sources are also connected. The 220 kV grid feeds the Auxiliary Transformer (TAE), which in turn supplies the class 1E and non-class 1E 6.25 kV busses. The 110 kV source is used in the event of unavailability of the 400 kV or 220 kV networks, fundamentally during refuelling outages.

In the event of a loss of off-site power (LOOP), the safeguards busses are fed from the corresponding 7200 KVA Emergency Diesel Generator. In addition, the 220 kV line coming from the Ribarroja hydroelectric plant would allow feed to be provided to the normal and safeguards busses in dedicated mode ("island configuration").

In the event of Station Blackout (SBO*),* i.e. loss of off-site sources and of the aforementioned Diesel Generators, use will be made of a third 2814 KVA Diesel Generator, which is capable of feeding the battery chargers and Hydrostatic Test Pump in order to maintain injection to the RCP seals or make up of inventory to the reactor coolant system.

- Heat Sink

The plant has two heat sinks. The main sink is the Mediterranean Sea, with several pumping systems that provide cooling water for the removal of thermal loads in normal operation, but which may also be used in the event of an accident. The alternative heat sink (Ultimate Heat Sink, UHS) consists of two forced draught cooling towers with two redundant pumping systems and cooling water distribution, and a cooling water pool providing an autonomy of 30 days. This heat sink is Seismic Category I and is protected against the possibility of flooding by the sea by its being located at a height of at least 20 metres above sea level.

- Containment Building

This building is of the Large Dry Containment type and has a free volume of 62,115 m^3. The building is made up of a vertical cylindrical wall (40 metres in diameter) which is closed at its upper part by a semi-spherical dome (63.40 m interior height), and is constituted by a reinforced concrete structure with additional prestressing of the cylindrical wall and semi-spherical dome by means of a system of post-taut tendons. The foundation slab is of reinforced concrete and has a cavity housing the reactor vessel.

The inner wall of the Containment Building is equipped with a liner (carbon steel plate) providing leaktightness, since in order to be acceptable the leakage rate must be lower than 0.2% of the volume of the building per 24-hour period at the peak pressure that would be reached in the worst-case accident scenario postulated.

The reactor cavity is of the "dry" type, this meaning that in order to achieve the entry of water, it is necessary to discharge in containment a volume of water greater than that of the RWST.

The design pressure and temperature of the Containment Building are 3,796 kg/cm^2 relative (54 psig) and 148.9 ºC (300 ºF). The analyses performed within the framework of Level 2 PSA have determined that the limit capacity of the building (pressure at which leaktightness failure would occur) is 8,667kg/cm^2 relative.

- Spent Fuel Storage

The irradiated fuel is stored under water in the Spent Fuel Pool, located in the Fuel Building, which is annexed to the Containment. The structure of the building, including the pool itself and its cooling system, has been designed as Seismic Category I. The Spent Fuel Pool is made of concrete and lined with stainless steel, contains borated water and has a capacity equivalent to 1,594 storage positions. The cells are of borated stainless steel.

- Significant safety-related differences between the groups

Not applicable.

d) Scope and summary of results of Probabilistic Safety Assessment

In accordance with the requirements established by the CSN, the plant has the PSA models indicated below. These models are updated periodically and have in fact recently undergone an update as part of the process of renewing the operating permit of the facility.

- Level 1 PSA of On-site Events at Power.
- Level 1 PSA of On-site Events in Other Operating Modes.
- Level 1 PSA of On-site Flooding at Power.
- Level 1 PSA of On-site Fires at Power.
- Level 2 PSA of On-site Events at Power.

The results of the different models mentioned above are described below.

Level 1 PSA of On-site Events at Power: the core damage frequency obtained is 7.60E-06 /year, with reactor and turbine trip (30.84%) and loss of off-site 400 kV feed (14.68%) being the main contributors to the risk of the facility.

Level 1 PSA of On-site Events in Other Operating Modes: the core damage frequency (CDF) value obtained is 3.14E-5 /year, the main contributor to the risk of the facility being reduced vessel inventory situations (“half nozzle”).

Level 1 PSA of On-site Flooding at Power: the calculated value of core damage frequency due to on-site flooding is 5.69E-6/year, the most significant being the flooding of the Control building and flooding as a result of rupturing of the Fire Protection System (FPS).

Level 1 PSA of On-site Fires at Power: the calculated value of core damage frequency due to on-site fires is 6.00E-6/year, the most significant being fires in the Control and Auxiliary buildings.

Level 2 PSA of On-site Events at Power: the overall results obtained are as follows:

- Frequency of Major Early Releases (FMER): accidents involving the off-site emission of volatiles to more than 3% of the core inventory within 12 hours of initiation of the accident: 8.09E-08 / year.

- Frequency of Major Releases (FMR): accidents involving the off-site emission of volatiles to more than 3% of the core inventory within 24 hours of initiation of the accident: 9.24E-08 / year.

The main contributors to the risk of the facility are sequences involving penetration of the foundation slab and rupturing of the containment as a result of overpressure.

3.3 COFRENTES NPP

Cofrentes nuclear power plant is fully owned by the electricity utility Iberdrola Generación S.A.U.

a) Site

The Plant is located on the right bank of the river Júcar, close to the tail of the Embarcaderos reservoir in the municipality of Cofrentes, in the province of Valencia.

The plant is located on a platform resting to the East on the mountain chain that closes the valley of the Júcar and separated to the West from the river and the tail of the reservoir by a peninsula measuring almost 1 km in length. The height of the area immediately around the site is variable (Peña Lisa, Las Rochas, Loma de Serrano) but is more than 45 m above the maximum level of the water in the river and the reservoir (maximum level 325.8 m).

The site is located at a distance of 2 km from the village of Cofrentes and more than 3 km from Jalance. There is no population dispersed in the surrounding area. The esplanade on which the plant is built is at a height of 372 m above sea level and is located at a distance of some 65 km from the Mediterranean coast.

b) Description of the unit

Operating on the site is a single power reactor of the BWR 6 type, designed and supplied by General Electric, with a current licensed thermal power level of 3,237 MWt.

Construction of the plant began in September 1975, the reactor achieved first criticality in August 1984 and the plant was first coupled to the grid in October of that year, reaching 100% power in January 1985. Cofrentes Nuclear Power Plant began commercial operation in March 1985 and is currently in its 18th operating cycle.

- Reactor Coolant System

The Reactor Coolant System is made up of the pressure vessel, which houses the reactor core, and two recirculation loops, each equipped with a Coolant Pump.

- Engineered Safeguards

The main engineered safeguards systems are as follows:
- Emergency Core Cooling System (ECCS).
- Containment spray system, forming part of the Low Core Pressure Injection (LPCI).
- Suppression pool cooling system, forming part of the LPCI.
- Containment Isolation System.
- Containment Combustible Gases Control System.
- Control Room Habitability Systems.

All the safeguards systems are basically made up of two redundant trains, each of which is capable of carrying out the safety function assigned, and are designed as Seismic Category I systems, capable of withstanding the loads of the Design Basis Earthquake (SSE: Safe Shutdown Earthquake). These systems are housed in Seismic Category I structures that protect them against the external events postulated for the site.

The Emergency Core Cooling System (ECCS) is made up of the high pressure core spray (HPCS), low pressure core spray (LPCS), low pressure core injection (LPCI) and automatic depressurisation (ADS) sub-systems. The external water source for the emergency cooling systems is the Condensate Storage Tank.

The objective of the Containment Safeguards Systems is to reduce pressure and temperature in the Containment Building following the occurrence of the design basis accidents: loss of coolant accident (LOCA) and main steam line break (MSLB) upstream of the isolation valves, preventing the building design pressure and temperature from being reached. For its part, the Containment Isolation System causes the fluid transport lines penetrating the containment to be closed.

For their operation the safeguards systems require certain support systems (cooling/power supply), also designed as Seismic Category I.

- Electrical supply systems

The plant is equipped with 2 independent off-site electrical sources via various lines supplying power at 400 kV and 138 kV and constituting the preferential source for plant start-up and shutdown, as well as for feed for the normal 6,3 kV busses (A1, A2, A3 and A4) and safeguards busses (EA1 and EA2) during plant outages.

There is a "generation breaker" (52G) that allows the generator to be isolated from the rest of the system, thus making it possible to provide feed for the plant electrical services from the 400 kV switchyard in the event of tripping of the group, via the main transformer (T1) and the auxiliary transformers (T-A1 and T-A2).

In the event of a loss of off-site power (LOOP), the safeguards busses are fed by the corresponding 5,509 KVA Emergency Diesel Generator. In addition, preferential resetting from the Cofrentes, Millares II, Cortes II and La Muela hydroelectric stations is contemplated in the procedures, all of these having an autonomous start-up capacity.

In the event of a complete loss of alternating current (SBO: Station Blackout), i.e., loss of the off-site sources and of the aforementioned diesel generators, there is a third 3,000 KVA diesel generator that provides feed for the HPCS pump and corresponding auxiliary equipment, this allowing the inventory of the reactor cooling system to be maintained. Furthermore, the plant has a system, the Reactor Core Isolated Cooling (RCIC), which is equipped with a turbine-driven pump that takes suction from the Condensate Tank and that also allows reactor inventory to be maintained.

- Heat Sink

The plant has two heat sinks: the primary heat sink comprises a natural draught cooling tower that removes heat from the main condenser and a battery of forced draught towers that allow the thermal load of the auxiliary systems to be removed during normal operation. The alternative heat sink (Ultimate Heat Sink, UHS) is made up of a storage pool and three cooling water pumping and distribution sub-systems, the return of which is channelled via a set of spray nozzles that discharge to the pool, allowing the thermal loads to be dissipated in the event of an accident. The pool provides an autonomy for 30 days. This heat sink is Seismic Category I and is protected against the possibility of flooding by the river Júcar by being located far above its normal level.

- Containment Building

The Containment is of the GE Mark III type, with pressure suppressing capacity and a double containment structure consisting of a self-sustaining steel inner part surrounded externally by a reinforced concrete outer building.

- Spent Fuel Storage

The irradiated fuel is stored under water in two large pools (East Storage Pool, PACE, and West Storage Pool, PACO), both located in the Fuel Building annexed to the Containment. The structure of the building, including the pools themselves and corresponding cooling system, has been designed as Seismic Category I. The Spent Fuel Pool is made of concrete lined with stainless steel and has a storage capacity for 5,404 storage positions, following two re-racking processes during which the original racks were replaced with other more compact units.

- Significant safety-related differences between groups

Not applicable.

c) Scope and summary of results of Probabilistic Safety Assessments

In accordance with the requirements established by the CSN, the plant has the PSA models indicated below. These models are updated periodically and have in fact recently undergone an update as part of the process of renewing the operating permit of the facility.

- Level 1 PSA of On-site Events at Power.
- Level 1 PSA of On-site Events in Other Operating Modes.
- Level 1 PSA of On-site Flooding at Power.
- Level 1 PSA of On-site Fires at Power.
- Level 2 PSA of on-site events and flooding at Power.
- PSA of fuel pool during shutdown.

Level 1 PSA of On-site Events at Power: the core damage frequency (CDF) obtained is 1.186E-6/year, the main contributors to the risk of the facility being the "anticipated" transients without scram, ATWS (60.75%), followed by LOCA sequences (11.04%), SBO (10.87%) and transients (10.56%).

Level 1 PSA of On-site Events in Other Operating Modes: the core damage frequency obtained is 9.55E-7 / year, the following plant operating states most contributing to the risk of the facility:

- Reactor subcritical with vessel head in place in Operating Condition 4 (cold shutdown).
- Reactor subcritical with temperature below 100°C and vessel head in place in Operating Condition 4 (cold shutdown).
- Vessel head removed and water level higher than 7 metres above the vessel flange. Operating Condition 5 (refuelling).

Level 1 PSA of On-site Flooding: the core damage frequency obtained for on-site flooding is 9.88E-07/year, the most significant being the flooding of the Services Building (specifically the Control Room) due to spraying of the panels located in zone S2-39 and in the auxiliary building, with Fire Protection System (FPS) pipe breaks, in the first place, and pipe breaks in the Essential Services Water System (ESW) carrying plant services water during normal operation being the events most contributing to the final core damage frequency value.

Level 1 PSA of On-site Fires: the calculated core damage frequency value due to on-site fires is 4.91E-07/year, the most significant being fires in the Control, Services (electrical equipment areas) and Auxiliary (electrical equipment rooms) buildings.

Level 2 PSA of On-site events and flooding at Power: the overall results obtained are as follows:

- Annual frequency of Major Early Releases (FMER): 1.44E-07/year, the most important contributors being early failure of the vessel and containment and bypassing of the Drywell (DW) and sequences involving containment bypass and early failure of the vessel and containment and DW bypass.
- Annual frequency of major releases (FMR): 2.62E-07/year, with the major contributors being failure of the vessel with early failure of containment and delayed DW bypass, as well as those described previously for FMER.

Cofrentes NPP has an analysis of the fuel pool that was performed within the framework of an R&D project: "Application of PSA to other sources of radioactive materials at nuclear power plants". The result as regards the frequency of damage to the fuel in the pool is 7.62E-07/year, and the most important contributor is the complete unloading of the core during maintenance activities on an electrical division.

3.4 ASCÓ I and II NPP

Unit I of Ascó nuclear power plant belongs to the electricity utility Endesa Generación SA (100%). For its part, unit II belongs to the utilities Endesa Generación SA (85%) and Iberdrola Generación SA (15%).

a) Site

The site on which the plant is located occupies an area of approximately 2.43 km^2 and is situated on the right bank of the river Ebro, between the towns of Flix and Ascó in the province of Tarragona, at a distance of 110 km from the mouth of the river.

The plant site is divided into two by the railway line. Most of the plant installations are located between the railway line and the road, with the exception of the cooling water intake and discharge structures, the 380 kV switchyard and several non safety-related cooling towers.

The surrounding land is mainly given over to agricultural use, also with large areas of uncultivated land, and the only noteworthy industrial installation in the area is an electrochemical factory located at a distance of some 4 km from the plant.

In the vicinity of the plant the population is very small. The population density is considered to be practically zero within a radius of 2 km. Up to 4 km, the population density reaches a value of 130 inhabitants per km^2, due to the towns of Flix, Ascó and Vinebre, then decreasing strongly as from a radius of 5 km, such that within a circle of 40 km it amounts to a value close to 26 inhabitants per km^2. The most important population centre within this 40 km radius is Fraga, with 14,539 inhabitants.

The area has a Mediterranean climate, with mild winters and rather hot summers. The prevailing winds are warm and humid.

Where it passes the site, the river Ebro measures approximately 150 metres in width, and the average flow for the 68 year period for which data are available is 500 m^3/s. The minimum value recorded is 100 m^3/s. The river flows along the bottom of the valley and for more than half its total length (700 km) is susceptible to flooding during peak flow periods, the dams constructed in its basin increasing this effect. There are three important dams on the Ebro located upstream of the site. These are the Flix dam, with a reservoir of 11.4 hm^3 (currently reduced to 6 hm^3) located some 10 km upstream; the Ribarroja dam, with a reservoir of 267 hm^3 and located 30 km upstream; and the Mequinenza dam, with a reservoir measuring 1,530 hm^3 and located 70 km upstream.

b) Description of the units

There are two Westinghouse design three-loop pressurised water reactors (PWR) operating on the site, each with a nominal thermal power output of 2,40.6 MWt and with minor differences of no significance from the point of view of safety.

Unit I first reached criticality on June 17th 1983, and initiated its commercial operation on December 10th 1984. For its part, Unit II achieved initial criticality on September 11th 1985 and started commercial operation on March 31st 1986.

The following description is applicable to both units:

- Reactor Coolant System

The Reactor Coolant System is made up of the pressure vessel, housing the reactor core, and three loops, each with a Coolant Pump and a Steam Generator. One of the loops also incorporates the pressurizer in its hot leg.

- Engineered Safeguards

The main safeguards systems are as follows:

- Emergency Core Cooling System.
- Containment Depressurisation and Heat Removal Systems (Spray and Cooling Units).
- Containment Isolation System.
- Containment Combustible Gases Control System.
- Auxiliary Feedwater System.
- Control Room Habitability Systems.

All the safeguards systems are basically made up of two redundant trains, each of which is capable of carrying out the safety function assigned, and are designed as Seismic Category I systems, capable of withstanding the loads of the Design Basis Earthquake (SSE: Safe Shutdown Earthquake). These systems are housed in Seismic Category I structures that protect them against the external events postulated for the site.

The Emergency Core Cooling System (ECCS) includes a High Pressure Injection System, a Passive System (3 accumulators) injecting at medium pressure and a Low Pressure Injection System. These systems guarantee the integrity of the fuel in the event of the postulated reactor coolant system line break accident (LOCA: Loss of Coolant Accident). The actuation of the ECCS, along with the Containment Building and its safeguards systems (Containment Isolation, Spray System and Containment Cooling Units) guarantee that the established dose limits will not be exceeded.

The source of borated water for the active emergency cooling systems is the Refuelling Water Storage Tank (RWST), the inventory of which amounts to 1,506 m^3 (High Level).

The objective of the Containment Safeguards Systems is to reduce the pressure and temperature in containment following the design basis accidents: Reactor Coolant System line break (LOCA) and Main Steam Line break (MSLB), preventing the design pressure and temperature of the building from being reached and guaranteeing that the values reached are more than halved within 24 hours. For its part, the Containment Isolation System causes the lines transporting fluids through the containment to be closed.

The Auxiliary Feedwater System is designed to inject water into the Steam Generators in response to any event causing the reactor to scram, allowing sensible and residual heat to be removed from the core. The system is equipped with two electrically operated pumps and a steam turbine driven pump. Each of the three pumps is capable by itself of providing the steam generators with the flow required to remove the residual heat from the reactor core. The preferential source of water for the system is the Condensate Tank (908 m^3). As an alternative, there is the possibility to draw water from the cooling tower make-up storage pool with a capacity of 29,774 m^3.

For their operation the safeguards systems require support systems (cooling/power supply), also designed as Seismic Category I.

- Electrical supply systems

The electricity required for start-up and for emergency loads is taken from the 110 kV switchyard, which is connected to the 220 kV external grid and, by means of a 200 MVA transformer, to the 400 kV switchyard. Off-site supply for the safeguards systems is taken from the 110 kV grid via the 62 MVA Auxiliary Start-up Transformers (AST), of which there are 2 for each group.

In the event of a loss of off-site power (LOOP) to one of the groups, the 2 safeguards busses are fed by the corresponding 5,625 KVA Emergency Diesel Generator.

In the event of complete loss of alternating current (SBO: Station Blackout), that is to say the loss of both the off-site sources and the aforementioned Diesel Generators, there is a third 2600 KVA diesel (shared by the two groups) that may be connected manually to one of the safeguards busses of each of the nuclear groups.

- Heat Sink

The plant has two heat sinks. The first of these is the river Ebro, with several pumping systems that provide cooling water for the removal of thermal loads in normal operation, although they may also be used in emergencies. The alternative heat sink (ultimate heat sink, UHS) for each of the two groups is made up of two cooling towers, two redundant cooling water pumping and distribution sub-systems and a water storage pool, common to both groups and capable of providing water for 30 days. This heat sink is Seismic Category I and is protected against the possibility of flooding by the river Ebro by being located at least 18 metres above the normal level of the river.

- Containment Building

The containment is of the so-called Large Dry Containment type, with a free volume of 62,015 m^3. The outer structure of the building is a straight vertical cylinder (measuring 40 m in inner diameter and 59.060 m in interior height) with a toroidal-spherical dome and reinforcing ring, both of concrete reinforced with tendons for the post-tensioning of the structure. The foundation slab is of reinforced concrete and has a cavity for the reactor vessel.

The wall of the containment is lined with carbon steel plate in order to ensure the leaktightness of the structure, since the acceptable leak rate is lower than 0.2% of the volume of the building in a 24-hour period, at the peak pressure that would be reached in the worst-case accident postulated.

The reactor cavity is of the “dry” type, this meaning that in order to achieve the entry of water it is necessary to discharge into the containment a volume of water larger than that of the Reactor Water Storage Tank (RWST).

The design pressure and temperature of the Containment Building are 3.796 kg/cm^2 relative (54 psig) and 148.9 ºC (300 ºF), respectively. The analyses performed within the framework of the Level 2 PSA have determined that the limit capacity of the containment (pressure at which failure would occur) is 7.230 kg/cm2 relative.

- Spent Fuel Storage

The irradiated fuel is stored under water in the Spent Fuel Pool, located for each group in the Fuel Building, which is annexed to the Containment. The structure of the building, including the pool itself and its cooling system, has been designed as Seismic Category I. The Spent Fuel Pool is made of concrete and lined with stainless steel, contains borated water and has a capacity equivalent to 1,421 storage positions. The cells are of borated stainless steel.

- Significant safety-related differences between groups

There are minor differences between the groups that, as has already been pointed out, are of no significance as regards safety.

c) Scope and summary of results of Probabilistic Safety Assessments

In accordance with the requirements established by the CSN, the plant has the PSA models indicated below. These models are updated periodically and have in fact recently undergone an update as part of the process of renewing the operating permit of the facility.

- Level 1 PSA of On-site Events at Power.
- Level 1 PSA of On-site Events in Other Operating Modes.
- Level 1 PSA of On-site Flooding.
- Level 1 PSA of On-site Fires.
- Level 2 PSA of on-site events at Power.

The results of the different models mentioned above are described below.

Level 1 PSA of On-site Events at Power: the frequency of core damage obtained is 1.218E-5/year, the main contributors to the risk of the facility being reactor and turbine trip (25.73%), small-break LOCA (18.31%), steam generator tube rupture (12.81%) and loss of main feedwater (10.42%).

Level 1 PSA of On-site Events in Other Operating Modes: the value of the frequency of core damage obtained is 4.18E-6 / year, the events most contributing to the risk of the facility being overpressurisation and loss of off-site power in operating mode 4 (hot shutdown) and overpressurisation and small-break LOCA in RHR in mode 5 (cold shutdown).

Level 1 PSA of On-site Flooding: the calculated value of the frequency of core damage as a result of on-site flooding is 4.53E-6/year, the most significant events being the flooding of the Control building.

Level 1 PSA of On-site Fires: the calculated value of the frequency of core damage as a result of on-site fires is 9.83E-6/year, the most significant events being fires in the Control, Containment and Auxiliary buildings.

Level 2 PSA of on-site events at Power: the overall results obtained are as follows:

- Frequency of Major Early Releases (FMER): accidents involving off-site releases of volatiles amounting to more than 3% of the inventory of the core over the 12 hours following the start of the accident: 3.30E-07/year.

- Frequency of Major Releases (FMR): accidents involving off-site releases of volatiles amounting to more than 3% of the inventory of the core over the 24 hours following the start of the accident: 2.75E-06/year.

The main contributors to the risk of the facility are sequences involving penetration of the foundation slab and interface LOCA's (containment bypass).

3.5 ALMARAZ NPP

Almaraz nuclear power plant belongs to the companies Iberdrola Generación S.A.U., Endesa Generación S.A. and Gas Natural SDG S.A.

a) Site

Almaraz Nuclear Power Plant is located on the left bank of the Arrocampo brook reservoir in the municipality of Almaraz (Cáceres), 16.4 km west-southwest of Navalmoral de la Mata, 68.8 km east-northeast of the provincial capital, Cáceres, and 180 km west-southwest of Madrid. The plant is located at a height of 258 metres above sea level.

b) Description of the units

There are two Westinghouse design three-loop pressurized water reactors (PWR) operating on the site, with a rated power level of 2,956.6 (unit I) and 2,955.8 MWt (unit II), respectively. There are minor design differences between these units which are of no safety significance. Unit 1 reached initial criticality on April 5th 1981 and Unit 2 on September 19th 1983.

The following description is applicable to both units:

- Reactor Coolant System

The Reactor Coolant System is made up of the pressure vessel, housing the reactor core, and three cooling loops, each with a Coolant Pump and a Steam Generator. One of the loops also incorporates the pressurizer in its hot leg.

- Engineered Safeguards

The main safeguards systems are as follows:

- Emergency Core Cooling System.
- Containment Depressurisation and Heat Removal Systems (Spray).
- Containment Isolation System.
- Containment Combustible Gases Control System.
- Auxiliary Feedwater System.
- Control Room Habitability Systems.

All the safeguards systems are basically made up of two redundant trains, each of which is capable of carrying out the safety function assigned, and are designed as Seismic Category I systems, capable of withstanding the loads of the Design Basis Earthquake (SSE: Safe

Shutdown Earthquake). These systems are housed in Seismic Category I structures that protect them against the external events postulated for the site.

The Emergency Core Cooling System (ECCS) includes a High Pressure Injection System, a Passive System (3 accumulators) injecting at medium pressure and a Low Pressure Injection System. These systems guarantee the integrity of the fuel in the event of the postulated reactor coolant system line break accident (LOCA: Loss of Coolant Accident). The actuation of the ECCS, along with the containment safeguards systems guarantee that the established dose limits will not be exceeded.

The source of borated water for the active emergency cooling systems is the Refuelling Water Storage Tank (RWST).

The objective of the Containment Safeguards Systems is to reduce the pressure and temperature in containment following the design basis accidents: Reactor Coolant System line break (LOCA) and Main Steam Line break (MSLB), preventing the design pressure and temperature of the building from being reached and guaranteeing that the values reached are more than halved within 24 hours. For its part, the Containment Isolation System causes the lines transporting fluids through the containment to be closed.

The Auxiliary Feedwater System is designed to inject water into the Steam Generators in response to any event causing the reactor to scram, allowing sensible and residual heat to be removed from the reactor core. The system is equipped with two electrically operated pumps and a steam turbine driven pump. Each of the three pumps is capable by itself of providing the steam generators with the flow required to remove the residual heat from the reactor core. The preferential source of water for the system is the Feedwater Tank and, once this is depleted, the Condensate Tank or the essential services water system may be aligned manually.

For their operation the safeguards systems require support systems (cooling/power supply), also designed as Seismic Category I.

- Electrical supply systems

The electricity supply for start-up and for emergency situations is taken from the 220 kV switchyard, which is interconnected with the 220 kV off-site grid by means of two lines. An autotransformer links the 220 kV switchyard to the site 400 kV switchyard, to which 8 off-site lines connect. The 220 kV has a "ring" configuration and if a defect occurs in any of these circuits it is possible to isolate the affected line without this affecting the power supply to the start-up transformers.

In the event of a loss of off-site power (LOOP) in one of the groups, the 2 safeguards busses are fed via the corresponding Emergency Diesel Generator. In addition, several lines are available that allow power to be supplied from the Valdecañas, J. M. Oriol, Gabriel y Galán, Torrejón, Cedillo and Guijo hydroelectric stations.

In the event of a complete loss of alternating current (SBO: Station Blackout), i.e., loss of both the off-site sources and the 4 aforementioned diesel generators, there is a fifth generator which may be connected manually to replace any of the other four. All the services of this generator are stand-alone, including the air cooling and batteries, and have the same capacity, design requirements and qualification as the rest of the emergency diesel generators. Nevertheless, the plant is licensed to respond to a SBO for at least 4 hours.

- Heat Sink

The plant has two heat sinks: the Arrocampo reservoir and the essential services water pool. The primary heat sink, which is the Arrocampo reservoir, has several pumping systems that provide cooling water for the removal of heat loads during normal operation, although they may also be used in the event of an emergency as an alternative to the UHS. The alternative heat sink (Ultimate Heat Sink, UHS) consists of the essential services water pool, which is equipped with sprays and is common to both plant units. This sink is Seismic Category I and is located at approximately the same elevation as the rest of the plant buildings.

- Containment Building

The containment is of the so-called Large Dry Containment type, with a free volume of close to 60,000 m^3. The outer structure of the building is a straight vertical cylinder with a semi-spherical dome, both of reinforced concrete. The foundation slab is of reinforced concrete and has a cavity for the reactor vessel.

The wall of the containment is lined with carbon steel plate in order to ensure the leaktightness of the structure, since the acceptable leak rate is lower than 0.1% of the volume of the building in a 24-hour period, at the peak pressure that would be reached in the worst-case accident postulated.

The reactor cavity is of the “dry” type, this meaning that in order to achieve the entry of water it is necessary to discharge into the containment a volume of water larger than that of the RWST.

The design pressure and temperature of the Containment Building are 3.796 kg/cm^2 relative (54 psig) and 148.9 ºC (300 ºF), respectively. The analyses performed within the framework of the Level 2 PSA have determined that the limit capacity of the containment (pressure at which failure would occur) is 8.48 kg/cm^2 relative.

- Spent Fuel Storage

The irradiated fuel is stored under water in the Spent Fuel Pool, located for each group in the Fuel Building, which is annexed to the Containment. The structure of the building, including the pool itself and its cooling system, has been designed as Seismic Category I. The Spent Fuel Pool is made of concrete and lined with stainless steel, contains borated water and has a capacity equivalent to 1,804 storage positions. The cells are of borated stainless steel.

The fuel storage racks are high density units and are designed to ensure that there is an effective multiplication constant (Keff) equal to or lower than 0.95, even with the racks completely filled with fuel assemblies having the highest estimated reactivity, with the water in the pool having a boron concentration lower than that required by the Technical Specifications and with a temperature corresponding to the highest reactivity.

- Significant safety-related differences between groups

The two groups are essentially identical. The differences between them are of no significance as regards safety and are basically as follows:

In Group 1 there is a connection to the essential service water system to allow water to be injected to the Auxiliary Feedwater System (AFW) or to the spent fuel pool from external sources or by connecting equipment existing at the plant, and the same arrangement is planned to be implemented in Group 2 during the next refuelling outage.

In Group 2, one of the emergency diesel generators is of a different design from the others and the remote shutdown panels are currently located in different rooms, although these panels are undergoing an important design modification.

c) Scope and summary of results of Probabilistic Safety Assessments

In accordance with the requirements established by the CSN, the plant has the PSA models indicated below. These models are updated periodically and have in fact recently undergone an update as part of the process of renewing the operating permit of the facility.

- Level 1 PSA of On-site Events at Power.
- Level 1 PSA of On-site Events in Other Operating Modes.
- Level 1 PSA of On-site Flooding at Power.
- Level 1 PSA of On-site Fires.
- Level 2 PSA of on-site events at Power.
- Level 1 PSA of Other Off-site Events.
- PSA of Fuel Pool with the plant in shutdown.

Level 1 PSA of On-site Events at Power: the frequency of core damage obtained is 3.11E-6/year, the initiating events making the largest contribution being generic transients (26.70%), small-break LOCA's (16.24%) and Loss of the Component Cooling Water System (14.99%).

Level 1 PSA of On-site Events in Other Operating Modes: the frequency of core damage obtained is 2.52E-6/year, the initiating events making the largest contribution being Losses of the Residual Heat Removal System (RHR) due to failure of its support systems with the RCS partially filled, Loss of Off-Site Power with the RCS full and partially full, and losses of RCS inventory under reduced inventory conditions. The normalised risk per unit of time is slightly higher in the Operational Conditions (EOPs) with the RCS partially full or draining that in other conditions, and significantly lower when the refuelling cavity is full.

Level 1 PSA of On-site Flooding: the calculated value of core damage frequency as a result of on-site flooding is 3.66E-06 / year, the most significant flooding events being those resulting from Component Cooling (CC) Water System line breaks and, to a lesser extent, line breaks in other systems potentially affecting the pumps of the aforementioned system (CC) on the lower floor of the Auxiliary Building and/or the operating logics of Essential Services Water System (SW) pumps.

Level 1 PSA of On-site Fires: the calculated value of core damage frequency as a result of on-site fires is 1.98E-05 / year, the most significant events being fires affecting the safeguards bus of Train B and fires in the control room (although the risk in this areas is expected to decrease significantly following the implementation of the design modification currently under way, and consisting of the incorporation of an Alternative Shutdown Panel) and in the vicinity of the Train A safeguards bus.

As a result of the Fires PSA, the plant is planning to carry out a series of design modifications aimed at improving the plant response to fires. With these modifications and the implementation of the Alternative Shutdown Panel referred to above, it is expected that the risk of the plant as regards fires will decrease significantly.

Level 2 PSA of on-site events at Power: the overall results obtained point to a frequency of major early releases from containment of 2.51E-07/year. The release categories that most contribute to this frequency are those associated with interface LOCA initiating events and, to a much lesser extent, those associated with containment isolation failures and early failures of the containment.

PSA of Other Off-site Events: the overall core damage frequency associated with off-site events and resulting from this analysis is 1.54E-06/year.

PSA of Fuel Pool with the plant in shutdown: the value of frequency of damage to the fuel assemblies stored in the spent fuel pool is 3.11E-08/year.

3.6 SANTA MARÍA DE GAROÑA NPP

SM de Garoña Nuclear Power Plant belongs to the electricity utility Nuclenor S.A., a company that is jointly owned in equal proportions by the companies Iberdrola Generación S.A.U. and Endesa Generación S.A.

a) Site

The Garoña plant is located on a meander of the river Ebro that forms a peninsula measuring approximately 0.37 km^2. This meander is situated at the tail of the Sobrón reservoir, close to the villages of Garoña and Santa María de Garoña, in the northeast of the province of Burgos.

The plant is located at a height of 518 metres above sea level at a distance of more than 100 km from the nearest coast.

b) Description of the unit

A single BWR 3 type power reactor designed and supplied by General Electric operates on the site, its currently licensed thermal power output amounting to 1,381 MWt.

The plant first reached criticality on November 5th 1970 and began commercial operation on March 2nd 1971.

- Reactor Coolant System

The Reactor Coolant System is made up of the pressure vessel housing the reactor core and two cooling loops, each with a Coolant Pump.

- Engineered Safeguards

The main engineered safeguards systems are as follows:

- Emergency Core Cooling System (ECCS).
- Containment Spray System, which is part of the low pressure core injection (LPCI).
- Suppression pool cooling system, which is part of the LPCI.
- Containment Isolation System.
- Control Room Habitability Systems.

All the safeguards systems are made up of two redundant trains, each of which is capable of carrying out the safety function assigned, and are designed as Seismic Category I systems, capable of withstanding the loads of the Design Basis Earthquake (SSE: Safe Shutdown Earthquake). These systems are housed in Seismic Category I structures that protect them against the external events postulated for the site.

The Emergency Core Cooling System (ECCS) consists of the high pressure core injection (HPCI), low pressure core spray (LPCS), low pressure core injection (LPCI) and automatic depressurisation (ADS) sub-systems.

The external source of water for the emergency cooling systems is the Condensate Tank.

The objective of the Containment Safeguards Systems is to reduce the pressure and temperature in containment following the design basis accident, which is the Reactor Coolant System line break (LOCA), including a Main Steam Line break upstream of the isolation valves, preventing the design pressure and temperature of the building from being reached. For its part, the Containment Isolation System causes the lines transporting fluids and penetrating the containment to be closed.

For their operation the safeguards systems require support systems (cooling/power supply), also designed as Seismic Category I.

- Electrical supply systems

The plant has 3 independent off-site electrical feed sources, provided via various lines supplying power at 400 kV, 220 kV and 138 kV, these constituting the preferential energy source for plant start-up and shutdown, as well as for the electrical feed of the normal and safeguards busses when the unit is shut down.

In the event of loss of off-site power (LOOP), the safeguards busses are fed via the corresponding emergency diesel generator, these generators each having a rated power of 2,100 kW. In addition, preferential replacement from the Sobrón, Trespaderne and Quintana hydroelectric plants is contemplated in the procedures.

In the event of complete loss of alternating power (SBO: Station Blackout), the ECCS-HPCI sub-system is available, equipped with a turbine-driven pump that takes suction from the Condensate Tank, allowing reactor inventory to be maintained, along with an Isolation Condenser with diverse make-up systems that allows residual heat to be removed from the core without any loss of inventory.

- Heat Sink

The plant heat sink is the river Ebro, which allows heat to be removed from the main condenser and auxiliary loads during normal operation, and residual heat and heat from the auxiliary loads in the event of an accident, by means of various pumping and water distribution systems. The cooling capacity of the river is guaranteed for 30 days, even in the event of rupturing of the Sobrón reservoir dam, located downstream of the plant. The emergency systems that take suction from the river are Seismic Category I and are protected against the possibility of flooding by the river Ebro by being located in a concrete cubicle designed to protect them against rises in water level.

- Containment Building

The containment is of the GE Mark I type, equipped with a double containment and pressure suppression capacity and with a design pressure of 4.36 kg/cm^2_{rel}. The primary containment is inertised with nitrogen gas during power operation and consists of two separate volumes: the Drywell, a steel vessel surrounded by a reinforced concrete structure, and the Wetwell, which houses the suppression pool and is made up of a toroidal enclosure of carbon steel.

- Spent Fuel Storage

The plant spent fuel is stored in a pool located inside the Reactor Building (Secondary Containment) at a height such that it can communicate directly with the refuelling cavity once flooded. The structure of the building, including the pool itself and its cooling system, has been designed as Seismic Category I. The spent fuel pool is made of concrete and lined with stainless steel and its spent fuel storage capacity was increased in 1997 through a re-racking process.

- Significant safety-related differences between groups

Not applicable.

c) Scope and summary of results of Probabilistic Safety Assessments

In accordance with the requirements established by the CSN, the plant has the PSA models indicated below. These models are updated periodically and have in fact recently undergone an update as part of the process of renewing the operating permit of the facility.

- Level 1 PSA of On-site Events at Power.
- Level 2 PSA of on-site events and flooding at Power.
- Level 1 PSA of On-site Events in Other Operating Modes.
- Level 1 PSA of On-site Flooding at Power.
- Level 1 PSA of On-site Fires at Power.
- Level 1 PSA of Other Off-site Events.

Level 1 PSA of On-site Events at Power: the core damage frequency (CDF) obtained is 1.61E-06/year. The main contributor to this frequency are the anticipated transients without scram (ATWS), which imply 50%, losses of off-site power (25%) and losses of service water (11%).

Level 2 PSA of on-site events and flooding at Power: the overall results obtained for the Frequency of Major Early Releases (FMER): accident with off-site volatile emissions exceeding 3% of the core inventory during the first 12 hours into the accident, are as follows:

- On-site events: 4.93E-08 / year.
- On-site flooding: lower than 1.0E-10 / year.

Level 1 PSA of On-site Events in Other Operating Modes: the core damage frequency value obtained is 7.41E-07/year. The highest contribution in this case (70%) is due to a scenario in which there are minor breaks in the recirculation lines or inventory losses as a result of maintenance activities with the cavity full and connected to the spent fuel pools.

Level 1 PSA of On-site Flooding: the calculated value of core damage frequency as a result of on-site flooding is 4.62E-07/year, the main contributor being floods caused by the rupturing of lines located at the intake structure.

Level 1 PSA of On-site Fires: the calculated value of core damage frequency as a result of on-site fires is 8.31E-06/year.

3.7 JOSÉ CABRERA NPP (in the dismantling phase)

In February 2010, the ownership of the José Cabrera nuclear power plant, which is currently in the dismantling phase, was transferred from the electricity utility Gas Natural S.A. to the Spanish radioactive waste management company Empresa Nacional de Residuos Radiactivos, SA (ENRESA).

a) Site

The José Cabrera Nuclear Power Plant is located in Almonacid de Zorita (Guadalajara), on the bank of the river Tajo, the operational level being at 604 metres. A single-loop pressurised water reactor (PWR) with a gross electrical output of 160 MW operated on the site until April 30th 2006.

b) Description of the group

The only facility existing on the site subject to the stress tests contemplated within the context of the European Union is the spent fuel storage installation.

- Spent Fuel Storage

The plant has a single spent fuel storage installation, the Individualised Temporary Storage (ATI) Facility for Spent Fuel Casks, which is located inside the area controlled by the licensee.

Between January and September 2009, all the spent fuel existing on the site (100.3 tons of heavy metal) was transferred to a dry storage system in 12 Holtec International HI-STORM 100Z type casks. This system is made up of a multi-purpose inner capsule (MPC), with a welded double seal, with a capacity for up to 32 fuel assemblies, the residual heat power of the overall MPC amounting to up to 30 kW.

These MPC's are placed inside an outer shielding module, with an annular space for the circulation of cooling air. This module has an outer shell and another inside of steel, protecting a 0.7-metre thick layer of high density concrete. Bearing in mind the progressive decay of the spent nuclear fuel, the residual heat power per container as of June 30th 2011 varied from 8.52 to 12.34 kW. It is, therefore, an installation in which the safety functions are ensured by passive means.

These containers are placed in an Individualised Temporary Storage (ATI) facility located on the plant site, at an elevation of 628 metres, this consisting of a slab of seismic design supporting the containers. There are no other structures in the vicinity whose collapse might affect the containers.

c) Scope and summary of results of Probabilistic Safety Assessments

Not applicable.

4. PRELIMINARY LICENSEE REPORTS AND CSN ASSESSMENT

On August 15th 2011, the licensees of the Spanish nuclear power plants submitted their preliminary reports to the Spanish Nuclear Safety Council (CSN) in response to the Complementary Technical Instructions relating to their Operating Permits issued by the said organisation and requiring them to implement the programme of stress tests agreed to at European level in the wake of the events that took place at the Fukushima nuclear power plant in Japan. These stress tests consist of re-evaluating the safety margins of the nuclear power plants in the light of the events that occurred at that Japanese plant. The facilities to which these instructions refer are the six nuclear power plants currently in operation and one other that, although currently in the dismantling phase, has an independent temporary storage facility (ATI) for its spent fuel on site.

The current Spanish fleet of operating nuclear power plants comprises 6 sites with a total of 8 units.

It should first be pointed out that the reports submitted on August 15th by the licensees refer only to the state of progress of the set of evaluations and checks that they are currently performing, and that submittal of the final report is scheduled for before October 31st of this year. Despite this, the reports presented already address most of the aspects required, this having made it possible to identify strong points and anticipate certain measures that might be adopted to reinforce the response of the plants to extreme events.

Pursuant to what was agreed to at European level, the scope of the licensees' evaluations was to include the following:

- Extreme natural events: earthquakes, flooding and other natural events
- Events involving the loss of safety functions due to loss of different power supply resources (LOOP, SBO) or of the ultimate heat sink
- Management of severe accidents affecting the reactor core and accidents involving loss of Spent Fuel Pool inventory and/or cooling.

In the event of there being any other type of spent nuclear fuel storage on the site, the robustness of the corresponding installations was to be analysed with respect to the aforementioned events.

4.1. GENERIC ASPECTS

The most noteworthy aspects included by the licensees in their reports and common to all the facilities are dealt with first.

<u>**Extreme natural events**</u>

- **Earthquakes:**

All the plants have reviewed the design basis of their structures, systems and components as regards response to earthquakes. The preliminary conclusions drawn by the licensees, and already verified by the CSN evaluation, point to adequate compliance with these design bases. In addition, the licensees have reviewed the data on the earthquakes that have occurred in the vicinity of their plants from the cut-off date, which was considered in the original studies to define the design basis earthquake, up to May 2011, and have concluded that the value adopted continues to be valid, if the methodology applied in the initial studies is still used.

In view of the progress made in site seismic characterisation methods, the CSN is considering a programme to update the said studies, in accordance with the most recent IAEA standards.

As regards the safety margins for this type of events, seismic IPEEE (Individual Plant Examinations for External Events) analyses were already available in Spain for all the operating plants, and these have been now extended in order to ensure a wider margin. The IPEEE analyses are oriented towards the identification of plant vulnerabilities with respect to external events beyond design basis. In keeping with the seismic margins methodology applied (EPRI and NRC methodology), the objective is to determine the so-called "high degree of confidence of low probability of failure" seismic capacity of the plant (HCLPF capacity). In this respect, a Review Level Earthquake was initially established, corresponding to a maximum horizontal acceleration of the ground of 0.3g, and as part of the extension already performed at some plants – and under way at others – a check is being carried out to determine whether the structures and components required to achieve and maintain safe shutdown are capable of withstanding it. In addition to the above, a check has been performed, or is being performed, on whether in response to this event the plant would be capable of maintaining its basic confinement functions, these being understood as relating to the integrity of the Containment Building, its isolation system and the Spent Fuel Pool. Certain plants have also proposed the revision of the seismic margins of the equipment necessary to respond to a complete loss of power (SBO) and to severe accidents, as well as the equipment that maintain the cooling of the spent fuel storage pool. The approach adopted by these licensees has been considered adequate by the CSN. As regards the initiative of extending the analyses of the seismic margins to include the equipment foreseen to address SBO and severe accidents, it would be advisable for all the plants to include these aspects in their final report.

In those cases in which the plant is located on a river with dams upstream of the site, the licensees have carried out an analysis of their structural resistance in order to verify, firstly, whether the dams would be capable of withstanding an earthquake of the same intensity as the plant safe shutdown earthquake. In all cases it has been seen that the dams in question are capable of withstanding earthquakes of higher intensity than those adopted as the seismic design basis at the site of each plant. The licensees are performing specific analyses to quantify the seismic margins available for each dam. Furthermore, and as a measure of conservatism, analyses have been performed of dams break as a result of earthquakes, along with assessments of the propagation of the flood that might cause such rupturing to the site of the nuclear power plant, with a view to determining the maximum credible flooding level at the plant for this reason and the time that the maximum peak flow would take to arrive at the site. The CSN is currently evaluating these studies, in which it is receiving the specific support of a national centre of recognised expertise in the analysis of dams.

As regards the possible effects induced internally by an earthquake (internal floods and fires), the reports of the licensees include a preliminary analysis of these phenomena, which should be completed in the final report.

- **Flooding**

All the plants have reviewed the design basis of the facility regarding floods caused by natural events off site. The preliminary conclusions drawn by the licensees, and verified by the CSN evaluation, indicate that these bases are being adequately fulfilled. In addition, the licensees assessed their situation with regard to the current understanding of such phenomena, concluding that the magnitude of the design basis flood selected continues to be valid.

In addition to the analyses of flooding due to upstream dams breaks dealt with in the previous section, the analyses contemplate flooding as a result of intense local rainfall, the flooding of rivers and gullies, tsunamis, tidal waves and extraordinary rises in sea level, groundwaters, etc. In all these cases, the maximum foreseeable event and resulting margins are analysed and various proposals for improvement are established.

- **Other natural events**

The analyses performed by the licensees have been based on a preliminary probabilistic screening process in which use was made of the results available from the IPEEE's in order to establish those external events, such as strong winds, snowfall or extreme temperatures, that might have an impact on the safety of each site. Events having a probability of occurrence of less than once every hundred thousand years were ruled out.

For each of these events, the licensees reviewed the original design basis and checked that the structures of the plant and components located in outdoor areas were adequately designed. Furthermore, attempts have been made to verify the existence of safety margins beyond the design basis for those events that are credible at each site. In this respect, the licensees will need to carry out additional analyses and consider possible reinforcement measures.

<u>Loss of safety functions</u>

- **Loss of power supply (off and on site)**

The reports submitted by the plants contain, firstly, a detailed summary of the alternating current electricity supply systems, including the distribution networks and on & off-site power sources. There is also an orderly description of the foreseeable sequences in the event of successive loss of off-site power (LOOP) and of on-site emergency and auxiliary sources (SBO), as well as of the applicable action procedures. In all cases, an analysis of battery depletion is also included. In all the reports additional measures are proposed to improve the robustness of the plants, with a view to achieving complete autonomy allowing this type of events to be addressed for a 24-hour period with the equipment existing on site, and for 72 hours relying only on light equipment brought in from outside the plant. The most noteworthy aspect is the inclusion of measures to maintain direct current supply to the controls and instrumentation required to maintain the plant in safe conditions in such a situation. Also relevant are the measures to recover the off-site power supply from nearby hydroelectric plants and the use of autonomous back-up equipment. In addition, the corresponding action procedures will be developed and training will be delivered to the personnel for the execution of these procedures.

Although it is not explicitly contemplated in the WENRA /ENSREG document, in view of the situation that occurred in certain of the groups at Fukushima, some of the licensees have also analysed the scenario of loss of direct current. The CSN considers that it would be advisable for all the licensees to complete their reports by including this issue in the final report.

In general, the descriptions and assessments provided by the licensees are considered correct, although aspects have been identified in relation to which the information should be extended in the final report.

- **Loss of heat sink**

The licensee reports first identify the different heat sinks existing at the facilities and their most relevant design characteristics. The reports then go on to analyse the successive loss of these heat sinks and the possible consequences, including the systems available to maintain the plant in safe conditions and the available times. The analyses performed conclude that these scenarios are bound by the complete loss of alternating current (off and on-site). Also included are certain proposals to improve the capabilities of the facility in response to this type of events.

The CSN has verified the consistency of these analyses. In general, the descriptions and assessments provided by the licensees are considered correct, although aspects have been identified in relation to which the information should be extended in the final report.

- **Simultaneous loss of power and heat sink**

All the licensees analyse this situation in their reports. A conclusion that has been drawn in general by all the licensees is that this situation is equivalent to those covered in the two previous headings and, therefore, that the improvement actions for possible limiting situations are the same as those described above.

<u>Accident management</u>

In this field, the plants detail the organisational aspects and the material resources at their disposal, in accordance with their respective Site Emergency Plans (SEP's). Some of the licensees state that they will analyse the convenience of increasing their available human resources. Also presented are the different operating procedures available at each plant to address accident situations, specifically the Emergency Operating Procedures (EOP's) and Severe Accident Management Guidelines (SAMG's). The licensees have announced the creation of an Emergency Support Centre, common to all the plants, which will be equipped with human and material resources capable of intervening at any of the plants in less than 24 hours.

As regards the first of these aspects, the CSN has identified the need to review the emergency response capacity, in relation to both material and human resources, and the corresponding Site Emergency Plans (SEP's), in order to take into account the lessons learned from Fukushima and, specifically, the capability to respond to extreme situations at plants with more than one group, as well as verification of the availability of emergency management centres adequate for severe accident situations.

The implementation of the "Severe Accident Management Guidelines" at the Spanish plants of US design, both pressurised water reactors (PWR) and boiling water reactors (BWR), has followed a path that has been parallel in time, such that all the plants have had action Guidelines for response to hypothetical severe accidents in force since 2001. The implementation of the Guidelines at the US design plants has been carried out following the practices used in the country of origin, without the installation of new equipment at the plant, since the management of possible severe accidents was foreseen using the equipment available at each plant. Analogously, in the case of Trillo NPP, the only plant of German design in the country, the implementation of these procedures (Operating Manual and Severe Accidents Manual) was undertaken with the support of the main vendor.

Both the EOP's and the SAMG's have been the subject of specific CSN requirements, including the initial and on-going training of the intervening personnel, as established in the CSN Instruction IS-12. Their development and maintenance are included in the habitual supervision processes of this organisation.

As regards the capacity to access the site in the event of natural disasters, by both the personnel and auxiliary equipment, some of the licensees should complete the information and analyses included in their preliminary reports and dealing with this issue. The licensees also include an analysis of the availability of on and off-site voice and data communications resources in events such as those considered in these stress tests. In this respect, the analyses presented should be completed, since it has been observed that they do not cover all the situations that should be considered.

- **Severe accidents management (reactor)**

As regards the **control of hydrogen in the containment,** the licensees point out that in order to manage hydrogen in a way that covers the entire range of foreseeable concentrations in the case of a severe accident and to improve the robustness of the plant, they will consider the installation of passive autocatalytic recombiners in those areas of the containment that might pose a risk of hydrogen accumulation (except Sta. Mª de Garoña NPP, where the primary containment is inertised and where the installation of recombiners in the secondary containment will be analysed, and Trillo NPP, where such recombiners are already installed in containment).

As regards the **prevention of overpressure conditions in containment**, the licensees state that they will analyse the possibility of installing a filtered vent, or study the feasibility of this measure, as an additional improvement to protect the containment or as a complement to the fission product scrubbing action already performed by the suppression pool (in the case of the Cofrentes and Sta. Mª de Garoña plants).

These measures are considered to be positive since they contribute to improving the capacity to maintain the core cooling functions and the integrity of the containment in severe accident situations. In the final report the licensees should describe the aforementioned measures in detail and, where appropriate, any additional measures not included in the progress reports, indicating their implementation plan. Furthermore, in their analyses they should consider the beneficial effects of installing filtering devices in the containment vents, such as for example the reduction of off-site releases in the case of a severe accident or the reduction of doses in other buildings hampering the performance of recovery or mitigation actions.

- **Management of accidents involving loss of Spent Fuel Pool inventory and/or cooling**

In this case the licensees identify the resources available for cooling of the pools and the supply of make-up water, analysing the time periods available for performance of the necessary replenishment actions.

In general, the descriptions and assessments provided by the licensees are considered correct, although aspects have been identified in relation to which the information should be extended in the final report.

- **Other spent fuel storage facilities**

In Spain there are currently two sites with temporary spent fuel storage facilities. In both cases these are dry storage installations based on a concept of passive cooling, for which steel casks are used. In their analyses the licensees identify the design bases applicable to address off-site events and the existing safety margins, along with the additional measures to be implemented to improve the safety of these facilities in relation to this type of events. The specific descriptions of the Trillo and José Cabrera nuclear power plants, included in the corresponding section, deal with these issues in greater detail.

4.2 SPECIFIC ASPECTS OF EACH OF THE FACILITIES

4.2.1. TRILLO NPP

Extreme natural events

- **Earthquakes**

Licensee's Position

The Trillo NPP report points out that the plant has a wide margin with respect to the safe earthquake (SE), established in compliance with the German standards as the design basis (0.12 g), considering the simultaneous effects of the pressure wave that would cause the rupturing of the feedwater tank, a high energy tank located in the Turbine Building, and that is postulated to coincide with the earthquake. It is also pointed out that procedures are available to address the potential consequences of the earthquake and that even considering loss of off-site power during the 72 hours following the earthquake there would be no need to use equipment from off the site.

Following the analyses now extended by the licensee, the latter has assigned to the plant a seismic margin of 0.20 g, and indicates that the possibility of an earthquake of this magnitude occurring is less than once every 220,000 years. Nevertheless, the licensee proposes to carry out whatever reassessments or equipment changes might be reasonably feasible to raise this margin to around 0.3 g.

As regards internal flooding caused by earthquakes, Trillo NPP indicates that the risks of flooding as a result of line breaks due to an earthquake, the automatic control systems and instrumentation for the detection and prevention of flooding, the tests and verifications to be performed on these monitoring and control systems and the compensatory measures and contingency plans to address the loss of monitoring or mitigation equipment have been identified, concluding that protection of the plant against such events is adequately guaranteed. Despite this, the licensee will analyse the seismic margins of those elements that constitute a barrier against possible major internal floods.

Finally, the licensee has also analysed the possible impact of the rupturing of nearby dams as a result of an earthquake and has concluded that this does not imply any risk of external flooding for the plant.

CSN evaluation

The seismic design bases of the plant are the same as those licensed for the original design. Their acceptability with respect to the requirements made by the CSN over time has been checked during the processes of seismic assessment carried out prior to the granting of the successive operating permits by means of specific analyses performed during the periodic safety reviews, and also through the different periodic and specific inspections performed within the framework of the CSN supervision and control processes.

Before the stress tests, the licensee had already accredited a seismic margin (HCLPF capacity) of 0.20 g for the plant, a limitation due to the capacity of certain components. The extension of the seismic margin analyses to include the spent fuel pool is necessary, according to the scope of the stress tests. According to the licensee, the actual seismic margin of the plant to maintain the integrity of the fuel is at least 0.24 g, and with a series of modifications and re-analyses might approach 0.3 g. These results need to be verified by the CSN by means of appropriate checks. The seismic margin analysis methodology applied does not make it possible to quantify margins of more than 0.3 g.

The actuations proposed are considered to be efficient to improve the robustness of the plant as regards the occurrence of earthquakes beyond the design basis. The results obtained and specific details of the actions to be implemented should be incorporated by the licensee in his final stress test report.

As regards protection against flooding as a result of an earthquake, the licensee's report identifies the design and licensing bases and compliance with them. The design analyses, as identified in the report, meet the requirements of the most updated revision of the standards.

Furthermore, within the framework of re-analysis of seismic margins, the licensee proposes to explicitly analyse a set of elements that constitute a flooding barrier and that are identified *a priori* as being important. The CSN evaluation considers the licensee's proposal to be adequate for the identification of potential vulnerabilities with respect to internal flooding as a result of earthquakes. This analysis should not initially rule out non seismic category I piping, sources of flooding and barriers identified in the flooding analysis as being susceptible to generating initiating events and affecting mitigation systems.

The licensee's preliminary report does not include analysis of the fires that might potentially be induced by an earthquake, as a result of which this issue should be included in the final report. The CSN considers that at least the main plant storage areas for combustible or explosive materials should be identified, with an analysis of their seismic capacity being performed by means of inspections, and feasible actions defined to improve seismic performance wherever possible.

- **Flooding**

Licensee's position

The new analyses performed by the licensee, using updated data, indicate that the maximum level of flooding, with return periods of one million years, would be very far from the level of elevation of the plant (margin of more than 100 m). As regards the possibility of flooding due to obstructions caused by ice, Trillo NPP concludes that it is highly unlikely that sufficient ice could be produced to cause an obstruction or flooding.

CSN evaluation

The flooding design basis is the same as that licensed for the original design and has been accepted by the CSN. Furthermore, the protections existing for these phenomena have been repeatedly inspected within the framework of the CSN supervision programmes.

The analyses of margins performed should be completed in the final report, along with consideration of the possibility of flooding due to the water table rising and its effects on underground galleries and other ESC's.

- **Other extreme natural events**

Licensee's position

The natural events that have passed the screening process aimed at ruling out those whose impact is insignificant are torrential rains, snow loads and high winds:

- In the first case, wide margins are available with respect to potential flooding due to torrential rains.
- As regards high winds, the wind speed considered for the design of the plant buildings and structures was 144 km/h. The load due to winds has been reassessed using updated meteorological data and the standards currently in force, and it has been concluded that the safety-related structures have margins of more than 100%.
- As regards loads due to snow, a load of 100 kg/m^2 on a horizontal surface was considered in the design. The load that might affect the capacity of the roofing exceeds 184 kg/m^2, equivalent to a 1.53 metre thick of snow, something that the licensee considers unthinkable at this site.

CSN evaluation

The screening of external events performed in order to establish the design basis is based on a very low probability of occurrence (10^{-5} per year), in keeping with the probabilistic methodologies included in the applicable IPEEE standards.

In order to address situations beyond the design basis and determine safety margins, consideration should be given to other credible events on the site, such as electrical storms (lightning), extreme temperatures, rising groundwater levels or external fires, which should be included in the final report.

Loss of safety functions

- **Loss of off-site power (LOOP)**

Licensee's position

Trillo NPP describes all the electrical feed paths available to the plant and the possibility of operating in "island" configuration, feeding its own auxiliaries. In its analysis it concludes that the off-site electrical feeds are highly reliable and provide confidence in the capacity to rapidly recover from a loss of off-site power. Unavailability of the off-site feed sources, along with loss of the capacity to operate as an "island", leads to a situation of loss of off-site power (LOOP).

In this situation, the feed for the safeguards and emergency equipment is provided by the automatic start-up of the four Safeguards Diesel Generators. As a back-up measure, there are a further four Emergency Diesel Generators that allow electrical feed to be maintained to the equipment required to take the plant to safe shutdown. All these diesel generators are designed as Safety Class and Seismic Category I. It is also important to point out that there is a clear physical and functional separation between the safeguards and emergency generation and distribution systems, since they are located in different buildings and separated by a distance of some 200 metres, their support systems also being independent.

The operating capacity of the safeguards diesel generators, without the need for support from outside the plant, exceeds 72 hours. In addition, portable equipment is available for the transfer of fuel between the different fuel storage tanks.

As an additional back-up measure, there are procedures contemplating the start-up of the nearby hydroelectric plants to recover off-site feed.

CSN evaluation

The possibility of a LOOP is contemplated in the plant design basis. The off-site lines have different origins and routes, this independence providing reliability for the supply as regards possibilities such as the postulated event (LOOP). It should be pointed out that the plant is equipped with feeds for its safety-related auxiliaries via the 400kV (through opening of the generation breaker), 220 kV and 132 kV networks. The grid operator has procedures for recovery by zones that take into account the preferential feed for nuclear power plants.

By way of a guarantee with respect to the aforementioned LOOP situation, the four safeguards diesel generators and the four emergency generators, without apparent common mode failures and all seismically designed, provide a highly significant level of security.

The plant includes a detailed justification of the autonomy of the diesel generators, demonstrating satisfactorily that it would far exceed the 72 hours considered. Cooling of the safeguards diesel generators is accomplished using essential services water, the functions of which may be carried out for 30 days without the need for make-up from off site.

The aspects indicated by the plant and summarised here are set out in the applicable licensing documents, and have been inspected repeatedly by the CSN throughout the lifetime of the plant, as a result of which there are no regulatory objections in this respect. The plant includes forecasts regarding the possibility of channelling gas-oil to the diesel generators from the auxiliary steam generation boilers, and of including an additional reserve of oil for the safeguards diesel generators in a secure zone, which would provide an additional margin of guarantee.

- **Complete loss of alternating current (SBO)**

Licensee's position

In the event of a complete loss of alternating current or station blackout (i.e., loss of both the safeguards and emergency generators), the following situation would arise: from the point of view of core cooling, the main characteristic is the loss of the steam generator feed function. If no measures were adopted, this scenario would lead to a situation of core damage under high pressure conditions. To prevent this, there are various ways of recovering feed to the steam generators: manual depressurisation of the secondary side allows cooling to be partially re-established by using the water existing in the main feedwater lines; in parallel to this, injection would be performed by means of the diesel-engined pump permanently installed for this purpose, which is capable of using the inventory of water of the emergency feedwater system. The analyses performed by Trillo NPP indicate that this strategy would allow for core cooling for more than 24 hours.

The plant claims that it will have available procedures to increase the autonomy of the batteries and that the correct alignment of the feed to the secondary would be guaranteed by the existing autonomies, all the valves remaining correctly aligned as from that time.

In an initial assessment, the plant has contemplated the following improvement actions: 1) Supply for the plant of portable equipment (diesel generator for operation following SBO with connection to the emergency 380 V a.c. supply for the feed of equipment such as batteries, ventilation and valve actuators, and a motor-driven pump for injection to the primary circuit and means for boration); 2) Improved earthquake resistance of the diesel-engined pump for alternative supply to the SG's, and of the adjacent structure; 3) Analysis of portable means for lighting and communication; 4) Analysis of the possibility of using portable feeds for the relevant I&C for bleed and feed of the secondary and the primary system; and 5) Procedural guidance on the systematic testing of off-site feed from hydroelectric plants.

CSN evaluation

The LOOP scenario with loss of the safeguards diesel generators is within the plant design basis and is the main reason for there being emergency diesel generators. In the section on LOOP, the plant includes measures aimed at guaranteeing the autonomy of the emergency diesel generators.

As regards the availability of fuel for the operation of these generators, bearing in mind that in the scenario considered the safeguards diesel generators would not be in use and taking into account the transfer operations (procedural), it would be possible to cover 21 days.

The LOOP situation with loss of the safeguards generators is considered in the applicable licensing documents (they are the plant design basis) and, therefore, has already been evaluated by the CSN and inspected on numerous occasions. Consequently, there are no regulatory objections in this respect.

In accordance with the design of the system, two reservoirs are required to guarantee supply for at least 10 hours. There is an interconnecting header between the four (allowing the complete contents of the 4 to be used in the event of failure on one of the trains) and there are connections for water to be supplied to the pools from other systems.

The improvement actions proposed by the plant for a situation of additional loss of the emergency diesel generators are considered adequate.

The conclusion of the CSN evaluation is that the analysis performed by the plant during this phase of reporting on progress is acceptable, although the final report should analyse in greater detail the limit situations presented by the plant, along with the improvements proposed. Particularly noteworthy among the measures proposed by the plant is the improvement of the seismic capacity of the diesel-engined pump and adjacent structures.

- **Loss of ultimate heat sink (UHS)**

Licensee's position

Trillo NPP describes the heat sinks existing at the plant and the sequence that would occur in the event of their being completely lost. In this case, core cooling would be maintained with the steam generators, relying on the emergency feedwater system.

o Loss of ultimate heat sink combined with SBO

In this case, if it were not possible to recover feed to the steam generators by means of the start-up and shutdown pumps, core cooling could also be maintained by feeding with the diesel-engined pump.

In addition, and in order to improve the capacities of the plant in response to possible losses of the ultimate heat sink, the licensee proposes to implement the following improvements and perform the following analyses:

- Implement measures allowing other sources of water to be used in the event of loss of the essential services water system, by means of flanged connections, portable pumps and hoses.
- Taking into account the functional dependence of the safeguards diesel generators with respect to the essential services water system, and bearing in mind that this system might be a potential source of flooding in the emergency diesel generator rooms:
    - Include in the reanalysis of seismic margins those elements that constitute a barrier to flooding of the emergency feedwater building (ZX) with water from the essential services water pools.
    - Contemplate in the procedures the possibility of locally operating the valves located in the rooms of the annulus building (ZB).

- Include in the reanalysis of seismic margins those elements that constitute a barrier to flooding of the annulus building (ZB) with water from the essential services water pools.

CSN evaluation

In general, the descriptions and assessments provided by the licensee are considered to be correct. The measures proposed by the licensee are considered positive to reinforce the robustness of the plant in response to scenarios of loss of both final heat sinks with and without SBO.

In addition to what the licensee points out in this section, a loss of ultimate heat sink would lead to loss of spent fuel pool cooling. This problem is dealt with in another section of this report, corresponding to "accident management measures currently available in scenarios of loss of the Spent Fuel Pool cooling function".

The licensee should describe in the final report his operating strategy for situations in which there is only one emergency chain available for cooling of the reactor and the spent fuel pool.

Accident management

- **Accident management measures affecting the reactor**

Licensee's position

Like the rest of the plants, the licensee describes the existing measures to prevent, mitigate and manage severe accidents, at the level of equipment, procedures and human resources. In this respect, the licensee analyses the different strategies contained in his Operating Manual and Severe Accidents Manual, which aim to maintain or recover the core cooling function. In addition, the Trillo plant points out that a primary depressurisation and feed (Bleed&Feed) system is currently in the design phase, the implementation of which will allow this action to be performed. Finally, Trillo indicates that it has a system of passive hydrogen recombiners installed inside containment.

In order to increase the robustness of the installation with respect to this type of event, Trillo NPP proposes a series of different actions. Thus, in addition to what is indicated in the general section regarding a new centralised Emergency Support Centre, it points out that, although it considers the emergency response organisation and resources it currently possesses to be sufficient, it will analyse possible actions to reinforce the response capability of the plant in this area. Furthermore, the plant claims that it has initiated the development of Severe Accident Management Guidelines (SAMG's) contemplating strategies to address situations that have given rise to core damage, and proposes the installation of a filtered containment venting system. Finally, in order to increase the robustness of the facility, it proposes to analyse the incorporation of portable equipment (portable diesel generator, motor-driven pump for make-up to the primary circuit, portable lighting and communications equipment and improvements to the instrumentation) providing support for the management of this type of accidents.

CSN evaluation

Both the Operating Manual containing strategies for accidents within the design basis and the guidelines or instructions contained in the Severe Accidents Manual (SAM) have been checked by the CSN by way of inspections and evaluations and are considered adequate for the performance of their accident-related function.

The evaluation concludes that the analysis and the measures to prevent fuel damage considered by the licensee are adequate. As regards the implementation of the additional measures based on portable equipment, the time required for such implementation should be analysed and taken into account.

In relation to the prevention of hydrogen deflagration and detonation, Trillo NPP is equipped with a passive hydrogen recombining system that has been designed specifically to control the concentration of hydrogen during severe accidents. Trillo NPP indicates that during the reanalyses performed in June 2011, it has verified that the resistance values of the anchoring points of this system are equal to or higher than those corresponding to the comparison earthquake (0.3 g) and proposes as an additional measure that the seismic margins of the internal components of these passive recombiners be verified. This measure is considered to be adequate.

As regards protection against containment overpressure, Trillo NPP proposes an additional measure consisting of installing a filtered containment vent qualified for severe accidents. The plant also proposes to undertake an improvement to the instrumentation for monitoring of the containment during severe accidents. These improvements are considered positive, although more details will be required to assess them more accurately.

As regards the resources available to estimate the amount of radioactive material released off site when such releases are required to protect the containment, the licensee should develop this analysis in greater detail.

In relation to potential accumulations of hydrogen outside containment in the event of a severe accident, the CSN evaluation considers that the licensee's provisional conclusion (no significant accumulations of hydrogen are expected outside containment in the event of a serious accident) is insufficiently grounded, for which reason the licensee should provide additional clarification in his final stress test report.

Furthermore, the CSN evaluation has identified various detailed issues that should be completed in the final report, such as the treatment of severe accidents in other operating modes, the radiological implications of emergency response and recovery actions, the availability of instrumentation in these scenarios, protection and dosimetry control measures and lighting and communication conditions, as well as the capacity of the equipment involved in the SAMG strategies to fulfil its function in the event of an earthquake and/or flooding, and the availability of boron to address potential re-criticality issues in the measures finally adopted.

- **Loss of spent fuel pool inventory and/or cooling**

Licensee's position

The analysis submitted details the different systems available in the plant to cool the pools and add inventory when necessary, and also underlines the fact that heat removal from the pool is guaranteed without the need for actions and in the worst-case scenario for more than 24 hours.

The licensee stresses that the location of the pool inside the containment building ensures that the potential release of fission products and hydrogen as a result of uncovering of and damage to the spent fuel would be confined to containment, and adds that the passive containment hydrogen recombiner system includes sufficient design margins to accommodate the potential hydrogen released in the spent fuel pool.

Despite this, and with a view to increasing the robustness of the plant, the licensee proposes to provide adequate portable equipment to ensure water make-up to the pool, as well as portable instrumentation and means to provide spraying of the spent fuel assemblies in the pool. The measures foreseen are as follows:

- Analysis of the feasibility of establishing an injection flow path to the spent fuel pool not requiring the personnel to access containment.
- Provision of an autonomous portable pump to provide water to the spent fuel pool via the fire protection system, along with means to spray the spent fuel assemblies in the pool.
- Provision of a portable generator to recover emergency d.c. feed and part of the emergency a.c. supply in order to ensure the availability of the pool instrumentation and the possibility of remotely operating valves, and portable instrumentation for monitoring (temperature, level).
- Provide the isolation valve of the third loop of the spent fuel pool cooling system with feed from an uninterrupted supply.

CSN evaluation

In general the descriptions and assessments provided by the licensee are considered to be correct. The measures proposed are considered to be positive, and it is expected that the licensee will present them in greater detail in the final report.

As regards the sloshing phenomenon (movement on the free surface of the pool when subjected to agitation), the CSN evaluation has determined that the licensee has not yet completed his analyses and has not, therefore, included complete results in his progress report. These results should be included by the licensee in the final stress test report.

In relation to radiological aspects, the CSN is evaluating the dose rates deriving from loss of level in the pool and included in the licensee's report, the results of which may imply a revision of the times available for performance of the local manual actions for water make-up to the pools. The analyses submitted should be completed in the final report with an analysis of the availability and suitability of the instrumentation to be used, as well as of the dosimetry control and protection resources for the workers.

- **Individualised Temporary Storage Facility for Spent Fuel Casks**

Licensee's position

The licensee describes the characteristics of the storage facility housing the casks. The building is seismic category I, since it is required to maintain its structural integrity during and after occurrence of the safety earthquake. The licensee's assessment concludes that a seismic margin of 0.3 g would be applicable. The only component fulfilling nuclear safety functions inside the facility is the cask itself, the seismic margin of which is determined in terms of overturn capacity, this being established in accordance with conservative calculations as a resulting maximum ground acceleration of 0.36g.

CSN evaluation

The structure of the ATI facility, although indeed seismic category I, was not included within the original scope of the IPEEE seismic analyses. In accordance with the methodology used for these analyses and the EPRI criteria applied, as in the case of the plant response analyses, assigning a seismic margin of 0.3 g is valid. However, the value assigned by the licensee to the storage cask itself as the only safety-related component must be checked by the CSN through the corresponding evaluation and inspection processes.

4.2.2 VANDELLÒS II NPP

<u>Extreme natural events</u>

- **Earthquakes**:

Licensee's position

The Vandellós II NPP report concludes that the plant has sufficient margin with respect to the earthquake established as the design basis, SSE (0.2g), as a result of which the safe shutdown of the reactor and maintenance of the confinement function of both the containment and the spent fuel pool are guaranteed in the event of an earthquake. Following the analyses performed within the IPEEE-Seismic project and revised in 2009 as part of the plant Periodic Safety Review, the seismic margin of the plant (HCLPF capacity) is higher than 0.3g. Complementary analyses of the seismic margin of the Spent Fuel Pool Cooling System, the Station Blackout equipment and the relevant equipment included in the Severe Accident Guidelines and not previously included in this programme are currently being performed.

As regards the potential effects of the earthquake, the licensee analyses the effect on non-seismic design piping. In this analysis the licensee concludes that it is not necessary to systematically analyse all non-seismic piping. However, he considers that the piping that might lead to flooding of certain areas of the plant containing important equipment and that might cause situations of significant risk should be analysed. These pipes have been identified in the risk analyses (Flooding PSA) performed, for which reason the licensee proposes as an improvement action that a documented evaluation of the seismic performance of these lines be performed, with a view to implementing actions to eliminate the possible vulnerabilities identified.

Another aspect considered by the licensee are potential fires caused by seismic activity. The design of the plant includes passive characteristics to prevent the propagation of fires between the safe shutdown equipment on both trains, automatic extinguishing systems to mitigate the consequences of fires and an organisation and technical resources for fire-fighting on the site.

As an additional measure, and with respect to events of seismic origin, an inventory will be drawn up of potentially significant sources of fire due to the storage of inflammable or explosive products, and an inspection will be carried out from the seismic point of view. The feasible modifications required will be implemented in order to provide this equipment with greater seismic robustness.

As regards the potential effects of seismic activity on nearby industries, the vulnerability of Vandellós II NPP to accidents at nearby industries had already been analysed prior to these stress tests in the context of the IPEEE studies on Other External Events. As of the date of the progress report, the only relevant installation is the Plana del Vent Combined Cycle Thermal Power Plant (CCTP), located at a distance of some 800 metres from the plant. According to the information provided by the owner of this facility, no substances that might generate an explosion are stored on the site. Explosions might arise in the event of formation of explosive clouds. The risk assessments performed have determined that for the most limiting break and overpressure induced by the deflagration of the inflammable cloud at the applicable distance, the most limiting of the events analysed would not affect Vandellós II NPP.

As regards the risk of the release of toxic substances from the CCTP, it has been determined that only five toxic substances are stored at the facility and that in the event of accidental release, only one, ammonium hydroxide, might reach the air intakes of the Vandellós II NPP control room in relevant concentrations. However, the maximum quantity stored at the CCTP is so small (1000 kg) that the concentration of this substance at the air intakes would be below the toxicity limit, even under the most unfavourable meteorological conditions.

CSN evaluation

The plant seismic design basis is the same as that licensed for the original design. Its acceptability with respect to CSN requirements has been verified over time within the framework of the seismic assessment processes carried out before granting the successive operating permits, by means of specific analyses performed during the periodic safety reviews, and also through the different inspections performed as part of the CSN supervision and control processes.

Prior to the stress tests, the licensee had already accredited a seismic margin (HCLPF capacity) of 0.3g for the plant, including the safety and confinement functions of the containment building and its isolation system. This had already been considered acceptable by the CSN. The extension of the seismic margin analyses to include the spent fuel pool is necessary in keeping with the scope of the stress tests. The results provided by the licensee in this respect need to be verified by the CSN by means of the appropriate checks.

The actions proposed are considered to be efficient as regards improving the robustness of the plant in response to earthquakes beyond the design basis. However, the scope of the non-seismic piping break analyses proposed by the licensee should be extended to include the systematic review of the rupturing of these pipes, without preliminary screening by means of probabilistic estimates.

Likewise, as regards fires produced by earthquakes, the evaluation considers that the action proposed by the licensee will contribute to identification and to the robustness of the facility. In those cases in which an adequate seismic margin (0.3g) cannot be demonstrated, the licensee should complete the study with an analysis showing that they would not affect the safe shutdown of the plant or the fuel pool and its cooling.

With regard to the potential effects of seismic activity on nearby industries and the possible effects of the release of toxic products, the CSN evaluation considers that the analyses carried out by Vandellós II NPP within the framework of compliance with the analyses deriving from the IPEEE and their conclusions are acceptable within the framework of assessment of this report.

- **Flooding**

Licensee's position

The level of water that would be reached at the closest point to the site as a result of the maximum probable flood would not reach the elevation of the site (100 m), as a result of which it would not be affected (this level is equivalent to elevation 89.5m, with a margin of 10.5 m with respect to the elevation of the site). The methodology used in determining the design wave gives a maximum value of 5.6m and, taking into account the location of the Engineered Safeguards System (System EJ) as the heat sink, the height of the wave required for a potential tsunami to affect the facility would need to exceed 23.25m, this not being considered credible at this site. The licensee concludes that there is an ample margin with respect to the maximum flood height under the conditions corresponding to the design basis, and maintains that there is sufficient margin with respect to the height of flooding in the worst potential scenario beyond the design basis. Nevertheless, the licensee will reanalyse the drainage capacity of the site and the seals of gallery penetrations in order to provide an additional margin.

CSN evaluation

The information included by the licensee in his report regarding those events that might give rise to flooding on the site is a summary of what is included in the Safety Analysis Report for Vandellós II NPP, which is an official operating document. Since the ultimate heat sink was modified and the new Engineered Safeguards System (System EJ) was implemented, a tsunami has been ruled out as the design basis, as it is not a credible event at the site. The overall design basis described is considered reasonable and adequate for the characteristics of the site.

Certain additional measures for protection against flooding have been adequately identified; these should be completed in the final report.

- **Other extreme natural phenomena**

Licensee's position

According to the licensee's analyses, the only significant extreme natural event would be high winds, the design basis being a wind speed of up to 204 km/h. In the analysis performed of external safety-related structures and tanks, the licensee concludes that there is a margin of 2.0 and 1.5 respectively in relation to these components.

CSN evaluation

In order to address situations beyond the design bases and determine safety margins, other credible events at the site should be considered, such as electrical storms, high temperatures, freezing conditions, hail and even external fires, all of which should be included in the final report.

<u>Loss of safety functions</u>

- **Prolonged loss of off-site power (LOOP)**

Licensee's position

Vandellós II NPP concludes that the off-site feeds offer a high degree of reliability and confidence in the capacity to rapidly recover the lost supply. As regards on-site electrical sources, it points out that the two existing Emergency Diesel Generators (EDG´s) are capable of withstanding a LOOP situation for more than 7 days without any additional support, and present an additional strength, since they incorporate an independent cooling system based on aero-coolers. Furthermore, the licensee plans to install a third emergency diesel generator with the same design requirements and qualification as the two existing units and the capacity to replace either of them.

CSN evaluation

This LOOP situation is within the plant design basis, with a coping time of 7 days, and has therefore been evaluated and licensed in previous stages of the lifetime of the plant, its different aspects having been inspected by the CSN.

The descriptions presented by the licensee are considered to be correct. The off-site lines have different origins and routes, this independence providing reliability for the supply as regards possibilities such as the postulated event (LOOP). The transfers between feeds have operated satisfactorily. The grid operator has procedures for recovery by zones that take into account the preferential feed for nuclear power plants. The performance of periodic tests on the recovery of off-site power from the hydroelectric plants increases the reliability of the off-site supply from these sources.

The CSN evaluation considers that the response to be expected from the plant in the event of LOOP is safe and in accordance with expectations, and that the facility is capable of withstanding this scenario without any additional support for more than 7 days, given the existing capacities in terms of fuel and lubricating oil.

- **LOOP with loss of normal back-up sources**

Licensee's position

The analysis performed by the licensee underlines the existence of an additional diesel generator (NDG), with the capacity to provide feed for the loads required for this scenario for at least 7 days. This generator is located in a separate building from the EDG's, has different support systems and is cooled by aero-coolers. In this scenario the plant is capable of withstanding the situation for more than 7 days without any additional support.

CSN evaluation

The total loss of on and off-site a.c. supply (SBO) is an event that is beyond the design basis of the operating plants, which was incorporated in the Licensing Bases following the publication of regulation 10CFR50.63, developed in Regulatory Guide 1.155. The coping time for SBO at Vandellós 2 NPP is 8 hours.

As a result of the aforementioned standard, the capacity to connect the NDG to the class 1E medium voltage bus of train A, and consequently the capacity to feed the loads required to address the loss of off-site power and normal back-up sources (EDG) was incorporated. With the support of this NDG, both the direct current and the 120 V alternating current of train A will be available.

The CSN evaluation concludes that the Essential Diesel Generator (NDG) is a strength, since it is located in a building separate from the EDG's with different support systems and is cooled by air.

The increase of the autonomy of the NDG to seven days requires that the reserve of fuel in its storage tank be increased, raising the level currently monitored.

As regards the primary inventory function, in the SBO situation the hydrostatic test pump taking suction from the refuelling water tank allows the inventory lost across the seals of the Reactor Coolant Pumps (RCP's) to be replenished for more than 10 days. The measures proposed to increase robustness, consisting of modifying the procedures, are considered to be adequate.

- **LOOP with loss normal and back-up sources and of NDG**

Licensee's position

The licensee's report indicates that in this situation only the batteries would be left as a power source. By design, each of these is capable of feeding the associated loads required for at least two hours. The report includes a reanalysis of these times, considering more realistic consumptions, and a new strategy of selective disconnection of loads, with which a value of more than 24 hours is obtained.

In this scenario, residual heat removal from the core would be accomplished via the steam generators by discharging to the atmosphere via the relief valves and maintaining secondary inventory by means of the auxiliary feedwater turbine-driven pump (AFWTP). Under these conditions it is not possible to maintain primary circuit inventory in the long term due to foreseeable leakage (across the seals of the Reactor Coolant Pumps). The licensee includes an analysis of the times to uncovering of the core and failure of the vessel and containment. Taking these analyses into account, the licensee proposes to incorporate portable equipment available on site in a secure location for electricity generation, allowing the autonomy to be increased to more than 72 hours and providing an alternative primary injection capability.

CSN evaluation

The plant has adequately identified the equipment foreseen for this scenario, in which the facility would respond to the situation with the help of the direct current systems: SG feed by means of the AFW turbine-driven pump and SG depressurisation by means of the relief valves. Under these conditions it would not possible to maintain primary circuit inventory in the long term due to leakage across the seals of the Reactor Coolant Pumps.

As regards increasing the autonomy of the batteries, the CSN considers that it is acceptable to use realistic best estimate criteria for the hypotheses to be considered and for the disconnection of unnecessary loads, which should be duly procedurised and trained. These analyses, and the autonomy values obtained, will be checked by the CSN along with the forecasts regarding portable resources, as quoted by the plant, for use during the first 24 hours. The licensee is currently performing a study for the specification of these resources, taking into account different hypotheses regarding the availability and/or accessibility of the distribution centres.

It is concluded that the plant's forecasts and proposals are acceptable, for this progress report.

- **LOOP with loss of normal back-up sources and batteries**

Licensee's position

The licensee points out that in this situation the only possibility remaining is the manual operation of the AFWTP's and SG relief. As a measure additional to what is set out in the previous section, the licensee proposes to incorporate portable equipment in order to provide an alternative make-up capacity to the steam generators. Furthermore, in order to improve the capabilities of the plant with respect to possible losses of power, the licensee proposes to implement initiatives such as the availability of portable motor-driven generators capable of providing feed for the hydrostatic pump, motor control centres or battery chargers, the availability or motor-driven pumps for the injection of water to the primary circuit or steam generators, or improvements to the lighting and communication systems, as well as performance of the corresponding analyses.

CSN evaluation

In this scenario of loss of direct current supply from the initial moment, only the possibility of manually operating the AFWTP's and SG relief remains to remove residual heat and delay potential core damage as long as possible. This manual operation strategy, and the feasibility of implementing the improvements contemplated, will be checked by the CSN and should be described in greater detail in the final report.

- **Loss of ultimate heat sink (UHS)**

Licensee's position

Vandellós II NPP describes the two existing heat sinks. These are similar in capacity and are totally independent, as a result of which the loss of one would not affect the capability to reach safe conditions. The plant has two heat sinks in accordance with its Safety Analysis Report, a primary sink identified as the EF system (cooled by seawater) and an alternative sink known as the EJ system (cooled by water storage pools). Also noteworthy is the existence of the Essential Chilled Water Systems, the heat sink for which is the atmosphere by means of a system of aero-coolers located on the roof of the Diesel Building.

- **Simultaneous loss of primary and alternative heat sinks**

Although the licensee indicates that the simultaneous loss of both heat sinks is not considered credible, given the physical layout and independence of the systems transmitting residual heat, this scenario is analysed and is concluded not to pose any possible limit situations.

- **Loss of primary and alternative ultimate heat sinks with SBO**

The analysis submitted concludes that the situations that might arise would be those corresponding to SBO.

CSN evaluation

The loss of the final primary heat sink is within the plant design basis and has been evaluated and licensed in previous phases. The equipment and procedures to address these situations have been repeatedly inspected by the CSN.

The loss of the alternative heat sink does not in itself cause any plant transient, since it has no functions during normal operation. Pursuant to the Operating Technical Specifications, the plant would be taken to the Cold Shutdown situation.

The loss of both ultimate heat sinks leads to a situation in which the critical systems and components for maintenance of the safety functions are the same as those considered in the section on loss of electrical feed. The measures proposed for those cases are also valid for these scenarios and are considered to be positive as regards reinforcing the robustness of the plant.

As regards the long-term operation (24 hours or more) of the auxiliary feedwater turbine-driven pump, this capability is not checked as part of the surveillance tests to which this component is subjected. The licensee should analyse the possibility of performing additional tests.

In general, the descriptions and assessments provided by the licensee are considered to be correct.

Accident management

- **Accident management measures affecting the reactor**

Licensee's position

As in the case of the rest of the plants, the licensee describes the measures relating to equipment, procedures and human resources in place to prevent, mitigate and manage severe accidents.

Vandellós NPP proposes a series of actions to increase the robustness of the facility in responding to this type of event. Thus, in addition to what is indicated in the general section regarding a new centralised Emergency Support Centre, following the definition of the new strategies, Vandellós announces that it will review the suitability of the human resources currently described in its Site Emergency Plan. It also indicates that it plans to install passive autocatalytic recombiners (PAR) inside containment to improve hydrogen control, that it is carrying out a study to determine the best option for the installation of filtered containment venting, that it is analysing the advantages and disadvantages of making it possible to inject water into the reactor cavity and, finally, that it is studying possible strategies to allow for spraying from the outside to mitigate the release of fission products.

CSN evaluation

Both the emergency operating procedures (EOP) and the Severe Accident Management Guidelines have been incorporated at this plant on the basis of the standards of the Westinghouse owners group, PWROG. They are considered adequate for the performance of their functions and have been checked by the CSN via inspections and evaluations.

The actions proposed by the licensee and the additional measures involving portable equipment to prevent fuel damage are considered positive. Consideration should be given in performing these actions to the time required for their performance and the times available before reaching the limit conditions whose prevention is sought. These measures have already been commented on in the sections of this report that deal with the loss of safety functions.

In his report the licensee includes accident management measures for the protection of containment integrity in the case of severe accidents, such as the implementation of passive autocatalytic recombiners reducing the concentration of hydrogen without depending on support systems. As a last line of defence, the licensee also proposes to determine the best option as regards the installation of filtered containment venting, taking into account aspects such as off-site dose and reduction of the source term.

The licensee identifies the equipment and resources available to estimate the quantity of radioactive material emitted off site in the event of having to perform a release to protect the containment, although the analysis should be extended to contemplate the radiological and environmental conditions present in the severe accident.

The CSN evaluation considers the measures described by the licensee to be correct and has identified various detailed aspects that the licensee should include in the final report, such as the potential accumulation of hydrogen in other buildings, the treatment of severe accidents in other operating modes, the radiological implications of the emergency response and recovery actions, the availability of instrumentation in these scenarios, dosimetry control and protection resources and lighting and communication conditions, and the availability of boron to address the potential for a return to criticality in the measures finally adopted.

- **Loss of spent fuel pool inventory and/or cooling**

Licensee's position

The analysis submitted analyses the situations of progressive loss of fuel pool inventory by evaporation, as a result of loss of cooling, and determines the times available for the performance of mitigation actions. Vandellós NPP does not consider significant leakage from the spent fuel pool (SFP) to be credible, since the structure of the building and the pool itself are designed for the SSE (0.2 g) and analyses have been performed of the seismic margins, verifying that the pool, the steel liner, the gates and their sealing system and the storage racks are capable of withstanding more than 0.3 g.

The process that would take place in the event of loss of pool cooling implies an increase in the temperature of the water to saturation conditions, with the corresponding loss of inventory due to evaporation, this also implying a loss of radiological shielding. If it is not possible to replace inventory, this process would continue until the level reached the upper part of the fuel assemblies, initiating the process of fuel degradation. The time calculated for the level to reach the upper part of the fuel is 114 hours in normal operation and 51 hours under the worst-case refuelling conditions. These times lead the licensee to state that in his opinion there are no limit conditions associated with this problem. Nevertheless, the licensee is analysing strategies entailing additional resources for make-up to the pool and spraying of the fuel, as well as potential improvements to the pool instrumentation.

CSN evaluation

In general the descriptions and assessments provided by the licensee are considered to be correct. The CSN evaluation has confirmed that the licensee has not yet completed his analyses, for which reason the results included in the progress report are not complete (missing among others are those relating to potential improvements to the instrumentation or to the phenomenon known as sloshing, which occurs on the free surface of the pool when it is subjected to agitation). The pending results should be incorporated by the licensee in his final stress test report.

As regards radiological aspects, the CSN is evaluating the dose rates derived from loss of level in the pool and included in the licensee's report, the results of which may imply a revision of the times available for the performance of local manual actions for water replenishment to the pools. The analyses submitted should be completed in the final report with an analysis of the availability and suitability of the instrumentation to be used and of the resources available for the dosimetry control and protection of the workers.

4.2.3 COFRENTES NPP

Extreme natural events

- **Earthquakes**

Licensee's position

The Cofrentes NPP report concludes that the plant has sufficient capacity above the SSE (0.17 g), as a result of which in the event of an earthquake the safe shutdown of the reactor and the maintenance of the confinement function of both the containment and the fuel pool are guaranteed, a "seismic margin" of up to 0.28 g being available. The licensee indicates that the possibility of increasing this to 0.3g will be analysed by replacing whatever components might be necessary. Other important plant structures have also been analysed and a margin equal to or greater than 0.3g has been seen to exist in the Auxiliary, Fuel, Services and Diesel buildings and UHS pool, this margin being greater than 0.5g in the case of the Reactor building and Primary Containment. The existence of a margin of more than 0.3g has also been determined for the structure of the spent fuel pools and the storage racks contained therein.

CSN evaluation

The seismic design basis for Cofrentes NPP is as licensed in the original design of the facility, is included in the Safety Analysis Report and has been repeatedly evaluated and inspected b y the CSN.

Prior to the stress tests, the licensee had already accredited an HCLPF capacity for the plant of 0.28g, a limitation due to the capacity of certain relays. The extension of the analysis of the seismic margins to include the spent fuel pool is necessary according to the scope of the "stress tests". The results provided by the licensee in this respect need to be verified by the CSN via appropriate checks. If these results are finally confirmed, the seismic margin of the plant might reach 0.3g.

The actions proposed are efficient as regards improving the robustness of the plant in response to beyond design basis earthquakes. The results obtained and the specification of the detailed actions should be incorporated by the licensee in his final stress test report.

As regards the effects of internal events deriving from earthquakes, such as internal floods and fires, the licensee has not included any analyses in his report. The CSN considers that the licensee should perform such analyses, taking into account the observations included in this report on the studies presented by other plants and include them in his final report.

- **Flooding**

Licensee's position

The design basis contemplating flooding considers the catastrophic rupturing of the Contreras dam (located 106 km upstream on the river Cabriel) coinciding with a flood caused by torrential rainfall of a magnitude equivalent to half the Probable Maximum Precipitation (PMP) and taking into account also the effect of 65 km/h winds causing waves in the mass of water. With this combination of events, the maximum height of the water surface would reach elevation 367.41, which is below the elevation on which the plant is built (372 m), as a result of which it would be possible to take the reactor to cold shutdown conditions and maintain fuel pool cooling even under these conditions.

In addition, the flood level due to instantaneous rupturing of the Contreras dam has been calculated, assuming it to be full to the maximum height. The maximum water level reached at the site is 361.99m, which would increase to 363.49 metres if consideration is given to the waves caused by the wind.

In all cases the 400 kV switchyard, located at elevation 348.7, would be lost; in accordance with the design, this would cause plant shutdown, the ESC's located on the plant ground surface level not being affected. The 138 kV switchyard is located on elevation 372, as a result of which it would not be affected. The route followed off site by the 138 kV lines running to Cofrentes NPP has also been analysed and it is concluded that these lines would be available even in the event of the maximum flood contemplated in the design.

The "limit situation" postulated would be a flood of unknown origin reaching the plant ground surface level (372 m). In this situation, off-site electrical feed would be lost due to the flooding of the 138kV switchyard, and the plant would depend on the emergency diesel generators (EDG's). In this situation it would be possible to take the plant to cold shutdown and maintain spent fuel pool cooling, since the flood level of the safety-significant buildings is located at least on elevation 372.20m. The duration of a flood is not expected to compromise the margins foreseen for the plant to maintain its safety functions only with on-site feed.

CSN evaluation

The design basis relating to the different events that might cause flooding of the site is included in the Safety Analysis Report and has been repeatedly evaluated and inspected by the CSN.

In the context of these stress tests, the CSN considers that the deterministic analysis that rules out the simultaneous rupturing of the Alarcón and Contreras dams should be updated, and that the dam rupture analysis should revised using updated databases and models.

The licensee states that the duration of the flood considered as constituting the "limit situation" is not expected to compromise the margins foreseen for the plant to maintain its safety functions only with on-site feed. Nevertheless, from the evaluation it is deduced that the period during which this situation might be supported should be estimated.

- **Other Extreme Natural Phenomena**

Licensee's position

Cofrentes NPP has analysed the possible occurrence of events caused by other external phenomena, identifying strong winds as the only relevant such case. The design wind speed for Cofrentes NPP is 150 km/h, calculated from studies of maximum winds in the area with a recurrence period of 1,000 years, and applying the criteria of the Spanish MV-101 building standards. The maximum wind speed measured to date at the site is 119 km/h. The resistance of the structures exceeds 150 km/h, due to the conservatism of this type of load calculations and the consideration of other criteria in design (e.g., seismic criteria).

CSN evaluation

The screening of external events performed to establish the design basis is based on a very low probability of occurrence (10E-5 per year), in accordance with the probabilistic methodologies included in the applicable IPEEE standard.

In order to address situations beyond the design basis and determine safety margins, other credible external events should be considered (such as snowfall, electrical storms, high temperatures, drought, ice, hail and external fires), and these analysis should be included in the final report.

<u>**Loss of safety functions**</u>

- **Prolonged loss of off-site power (LOOP)**

Licensee's position

Cofrentes NPP concludes that off-site power supplies provide high reliability and confidence in the possibility of rapidly recovering from loss of the off-site grid. As regards the on-site sources, it points out that the two existing Emergency Diesel Generators are capable of withstanding a LOOP situation for more than 7 days without any external support. Furthermore, there is an additional reserve of gasoil for other plant systems that might be channelled to the diesel generator tanks. The licensee plans to analyse the possibility of providing a portable feed source for this purpose, thus providing the diesel generators with a fuel autonomy of almost 30 days.

CSN evaluation

The LOOP is within the plant design basis, with a coping time of at least 7 days. Consequently, the situation considered in this sub-section has been evaluated and licensed in previous stages of the lifetime of the plant, and its various aspects have been inspected by the CSN.

The improvement action aimed at extending the autonomy of the DG's is considered adequate.

- **LOOP with loss of normal back-up sources (SBO) with and without the back-up of the HPCS diesel generator**

Licensee's position

As regards this event, Cofrentes points out that it has an additional diesel generator for feed of the High Pressure Core Spray (HPCS) system, which is electrically and seismically qualified. As an additional measure, the plant plans to develop a procedure to feed electrical divisions I or II from this diesel generator. If this additional diesel generator is not available, the Reactor Core Isolation Cooling (RCIC) system is available to inject water into the reactor, as indicated in the following paragraph.

The design basis considers an SBO of 4 hours, for which the following systems are available: the direct current system, the Reactor Core Isolation Cooling (RCIC) system, equipped with a turbine-driven pump, the HPCS system, the reactor relief and safety valves, with the capacity to depressurise the vessel, and the Fire Protection System (FPS), which is equipped with a pump fed by gasoil and has connections for the injection of water into the reactor, the suppression pool and the spent fuel pools and for containment spraying. In the SBO situation, the injection of water to the reactor would be carried out by the HPCS or the RCIC and, following depressurisation of the vessel, by the FPS system. In the event of a prolonged SBO, long-term heat removal would be carried out through opening of the dedicated containment vent (hard vent).

The plant has estimated battery autonomy stretch-out time through the different disconnections restricting the equipment connected to those actually needed for the situation considered, this estimate giving 20h 46m for battery "A" and 25h 4m for battery "B". An improvement action considered is the provision of mechanisms to extend the capacity of the divisional batteries.

Furthermore, to improve the capacities of the plant as regards possible power losses, the licensee proposes to implement the following improvements: optimisation of management of the fuel for the diesel generators, feed for divisions I or II from the HPCS diesel generator, procedurised manual operation of the RCIC without electrical feed or improvement of on and off-site communications and performance of the corresponding analyses.

CSN evaluation

The Station Blackout (SBO) scenario was incorporated in the licensing basis of Cofrentes NPP considering a coping time of 4 hours, without credit given to the Division III diesel generator as regards compliance with the SBO standards.

The actions planned to provide resources to extend operation of the batteries beyond 24 hours constitute a noteworthy measure to strengthen the response of the plant to these scenarios. Particularly noteworthy in this respect is the importance of the Division I battery, since it provides the direct current required for operation of the RCIC. The CSN evaluation will revise the hypotheses and estimates regarding extended battery life and the foreseen procedures through inspections, along with forecasts for the extension to at least 72 hours of the aforementioned periods.

Other noteworthy measures are the forecasts relating to the recovery of off-site power.

In addition to the information provided by the licensee, the final report should include more detailed information on the interventions to be performed using the FPS diesel pump and available sources of water, since this might have to be used to supply water to the vessel, spray the containment and provide water for the spent fuel pool. Likewise, specific information should be included on the use of the relief-safety valves to depressurise the vessel.

The final nature of the improvement actions proposed may be assessed more accurately in the following phase, although for the purposes of this report and in view of the comments already included in the previous sections, the licensee's proposal is considered acceptable.

As regards analysis of the situation of LOOP with loss of all back-up sources and of the batteries, the licensee does not analyse this case, which is not required in the ENSREG Stress Test document. As this case may be considered to constitute one of the lessons learned from the Fukushima event, the CSN considers that Cofrentes should complete its analysis in this respect.

- **Loss of Ultimate Heat Sink**

Licensee's position

Cofrentes NPP describes the possible situations that might arise in the case of loss of the UHS, which consists of a seismically qualified excavated pool. In the LOOP situation, the loss of the UHS would imply loss of the three diesel generators due to cooling failure, this leading to an SBO condition. Under these conditions the RCIC system and the Fire Protection System (FPS) would be available to inject coolant into the vessel. The latter could not be guaranteed if the situation were to coincide with an earthquake, since the system is not seismically qualified. Neither could credit be given to the Dedicated Containment Vent, since certain parts of the system are not seismically qualified. It is for this reason that redesigning the containment vent and the FPS sub-system used to inject to the vessel will be considered, in order for them to be functional following occurrence of a design basis earthquake.

Although the UHS is the only reserve of water to which credit is given as regards the earthquake, the licensee points out that at Cofrentes NPP there are various reserves of water that might be used with diesel motor-driven pumps: the 2 pools for releases, each with a capacity of up to 120,000 m^3, the channel and pools of the natural draught cooling towers and the local sources systems. Making use of these reserves might provide an additional plant improvement to address loss of the UHS, as a result of which Cofrentes NPP proposes to analyse and establish the appropriate connections to take advantage of these reserves.

- **Loss of Primary and Alternative Ultimate Heat Sink, with SBO**

This condition does not add any severity to the situation of this plant, since development of the transient is equivalent to that described in the previous section.

CSN evaluation

In general the descriptions and assessments provided by the licensee are considered to be correct. Loss of the essential services water final heat sink coinciding with LOOP would lead to a situation of SBO without HPCS. As the cooling of the three safeguards diesel generators depends on the UHS, it is considered appropriate that the licensee should analyse the feasibility of introducing complementary measures.

The measures proposed by the licensee, along with certain of those identified in the sections on loss of power, are considered to be highly positive to reinforce the robustness of the plant in response to this accident scenario, although in order for them to be assessed more accurately the licensee should include greater detail in his final stress test report. The impact of loss of the ultimate heat sink on the spent fuel pool cooling capacity is analysed in another section of this report.

Accident management

- **Measures for the Management of Severe Accidents affecting the reactor**

Licensee's position

As in the case of the rest of the plants, the licensee describes the existing measures at the level of equipment, procedures and human resources to prevent, mitigate and manage severe accidents. Also described is the use of the guidelines and procedures as plant conditions become degraded.

In concluding its analysis, Cofrentes NPP proposes different actions to increase the robustness of the facility in responding to this type of events. In this respect, in addition to what is indicated in the general section in relation to a new centralised Emergency Support Centre, and at such time as the definition of the new strategies is completed, Cofrentes NPP announces that it will revise the suitability of the human resources currently described in its Site Emergency Plan. Cofrentes also indicates that in order to strengthen the protection against severe accidents, and in support of the function of the existing hydrogen igniters, it will analyse the installation of passive autocatalytic recombiners (PAR) in those areas of the containment that might pose a risk of hydrogen accumulation. Likewise, the elevation of the suction of the current dedicated containment vent will be modified to make it compatible with the containment flooding strategy (in addition to improving its seismic design, as has already been pointed out) and the advisability of installing a filtering system additional to the pool scrubbing function performed by the suppression pool will be analysed; as regards control room habitability, additional measures will be analysed in order to guarantee the maintenance of control room pressurisation in the event of prolonged SBO.

The licensee is considering other measures that might have a positive impact on the management of severe accidents: assured supply of air for the actuation of the relief-safety valves and containment vent valves and capability of injecting water into the vessel, the suppression pool and the spent fuel pools by means of pumping groups that might take water from different sources and supply it to the vessel.

CSN evaluation

As a general conclusion, the descriptions and assessments provided by the licensee are considered to be correct, although there are aspects that have not been dealt with sufficiently and that will need to be completed in the final report.

Several measures for action in the event of severe accidents were already being developed in response to a CSN requirement within the context of the 2011 Periodic Safety Review. These measures relate to the control of hydrogen in containment, filtered containment venting and the containment flooding strategy, as a result of which the actions foreseen by the licensee in relation to these issues are considered adequate. As these requirements were established before the Fukushima accident, the CSN expects that in the action plan to be included in the final report the licensee will not simply comply with what was then required but speed up the definition and implementation of the foreseen measures to the extent possible.

The redesign of the current containment vent system proposed by the licensee, in order to ensure its operability after the occurrence of a design basis earthquake, is considered adequate and should be completed with an analysis of the seismic margin of the system. In the analyses relating to the installation of filters in the containment vent, consideration should be given to the positive effects due to the reduction of off-site releases and the reduction of doses in other plant buildings.

Likewise, the licensee should develop in greater detail the analysis of the resources available to estimate the quantity of radioactive material emitted off site in the event of a release having to be performed to protect the containment, considering the suitability of the instrumentation under the radiological and environmental conditions present in the case of the accident and the doses that the workers might receive when taking samples or carrying out radiological measures.

As regards the feasibility and effectiveness of the existing accident management activities under conditions of extreme risk, the capacity of the systems participating in the EOP-SAM strategies to fulfil their function in the event of earthquakes or flooding should be specifically analysed. This information should be included in the final report.

As regards the instrumentation available in these scenarios, the information included in the progress report is not sufficiently developed, and should be extended in the final report.

There are other aspects that should be completed in the final report, such as the potential for the accumulation of hydrogen in other buildings, the treatment of severe accidents in other operating modes, the radiological implications of the emergency response and recovery actions and the lighting and communications conditions, as well as the availability of boron to address possible return to criticality conditions in the measures finally adopted.

- **Loss of spent fuel pool inventory and/or cooling**

Licensee's position

The analysis presented analyses the situations of progressive loss of fuel pool inventory due to evaporation and as a result of loss of cooling, determining the times available for performance of the mitigation actions that would be carried out in accordance with the existing operating procedure and that has now been revised to include measures for management of the accident up to the onset of the fuel being uncovered.

The analyses performed by Cofrentes NPP indicate that the minimum time value up to the initiation of boiling in the most unfavourable situation (i.e., operation during refuelling with the core completely unloaded into the pool), would be 10 hours as from loss of pool cooling and 97 hours until uncovering of the spent fuel.

Finally, Cofrentes points out that a new strategy has been drawn up for the distribution of the assemblies stored in the spent fuel pools that implies an improvement in cooling in the event of uncovering of these assemblies.

CSN evaluation

In general, the descriptions and assessments provided by the licensee are considered to be correct.

The CSN evaluation has shown that the licensee has not yet completed his analyses and, has not, therefore, included in his progress report the complete results (missing among others are the potential improvements to the instrumentation or the phenomenon of sloshing (a movement that occurs on the free surface of the pool when it is subjected to agitation); these items should be incorporated by the licensee in his final stress test report.

As regards radiological aspects, the CSN is evaluating the dose rates deriving from loss of level in the pool and included in the licensee's report, the results of which may imply revision of the times available for performance of local manual actions to replace the water in the pools. The analyses submitted should be completed in the final report with analysis of the availability and suitability of the instrumentation to be used, as well as the dosimetry control and protection resources for the workers.

The measures proposed by the licensee are considered positive, and it is expected that they will be covered in greater detail in the final report, especially the issue of the strategies for the distribution of the assemblies stored in the spent fuel pools.

4.2.4. ASCÓ NPP

<u>**Extreme natural events**</u>

- **Earthquakes:**

Licensee's position

In the report, Ascó NPP concludes that the plant has sufficient capacity above the SSE (0.13 g), as a result of which the safe shutdown of the reactor and maintenance of the confinement function, of both the Containment and the Fuel Pool, would be guaranteed in the event of an earthquake, a "seismic margin" of 0.3g being available. The licensee also points out that complementary seismic margin analyses are being performed on the Spent Fuel Pool Cooling System, the Station Blackout equipment and the relevant equipment included in the Severe Accident Guidelines.

The licensee has analysed the resistance capacity of two important dams existing on the river Ebro, upstream of the site: Mequinenza and Ribarroja, and concludes that they are capable of withstanding the site design basis earthquake.

The licensee includes in his report the effect of an earthquake on non-seismic design piping. In concluding his analysis the licensee indicates that he does not consider it necessary to systematically analyse all the non-seismic piping.

The licensee considers, however, that those pipes that might produce these effects in certain areas of the plant that contain important equipment and that might give rise to situations of significant risk should be analysed. These pipes have been identified in the risk analyses (Flooding PSA) performed, for which reason the licensee proposes as an improvement action that the seismic performance of these lines be assessed, with a view to taking actions to eliminate whatever possible vulnerabilities might be identified.

Another aspect considered by the licensee are potential fires caused by seismic action. The licensee indicates that at Ascó NPP the design of the plant incorporates passive characteristics to prevent the propagation of fires between the safe shutdown equipment of the two trains, automatic extinguishing systems to mitigate the consequences of fires and an organisation and technical resources for fire-fighting on site.

As an additional measure, and in relation to events of seismic origin, an inventory will be drawn up of potentially significant sources of fire due to the storage of inflammable or explosive products, and an inspection will be performed from the seismic standpoint. The necessary feasible modifications will be implemented to provide this equipment with greater seismic robustness.

As regards the effects of external industry, the only relevant facility in the case of Ascó NPP as of the date of the study is the Erkimia Electrochemical Plant, located in Flix at a distance of some 4 km from the Plant. This facility produces chlorine and its derivatives. According to the licensee, 31 substances that might be considered explosive, toxic or suffocating are stored at this facility. In the majority of cases the quantities stored do not exceed 1000 kg.

The IPEEE study at Ascó NPP considered the risk deriving from an explosion and concluded that explosions at the Erkimia Plant might be ruled out as a source of risk for Ascó NPP. As regards the risk of toxic releases, it was determined that there are several substances that might reach the air intakes of the Ascó NPP Control Room in relevant concentrations. All of these, with the exception of chlorine under the most unfavourable meteorological conditions, would not reach the toxicity limit for the operators, even without Control Room isolation.

In the case of chlorine, Control Room isolation occurs and the operating personnel have to use the autonomous breathing equipment available. In the event of an earthquake, the detector (mass spectrograph) might be damaged, for which reason the Control Room should be manually isolated when the plant seismic monitoring system warns of the occurrence of an earthquake at the site.

CSN evaluation

The plant seismic design basis, for both groups, is the same as that licensed for the original design. Its acceptability with respect to the requirements set out over time by the CSN has been checked by way of the seismic evaluation processes carried out prior to granting of the successive operating permits, by means of specific analyses performed within the framework of the periodic safety reviews, and also by way of the various inspections performed as part of the CSN supervision and control processes.

Previous to the "stress tests", the licensee had already accredited an HCLPF capacity of 0.3g for the plant, including the safety and confinement functions of the Containment Building and its Isolation System. The extension of the seismic margins analyses to include the spent fuel pool is a necessity according to the scope of the "stress tests". The results submitted by the licensee in this respect need to be verified by the CSN by means of the appropriate checks. If finally confirmed, the seismic margin of the plant would be 0.3g to all intents and purposes.

The actions proposed are considered to be effective as regards improving the robustness of the plant in response to beyond design basis earthquakes. The results obtained and the specific actions to be taken should be detailed by the licensee in his final stress test report.

As regards earthquakes beyond the DBE and the flooding produced by them, the licensee has analysed the resistance of the dams upstream with respect to the seismic design basis of the plant and has also determined the seismic capacity of the Mequinenza and Ribarroja dams. The results obtained by the licensee indicate that both dams would withstand the Ascó design basis earthquake (furthermore, the seismic capacity of the Mequinenza dam is 1.20 times the DBE and the Ribarroja dam has a factor of 1.08 with respect to the DBE). These results are being checked by the CSN by means of the corresponding evaluation and inspection processes.

As regards analysis of the performance of non-seismic piping, the CSN evaluation considers that the actions proposed by the licensee will be effective to improve the robustness of the plant in response to beyond design basis earthquakes. However, the scope of the non-seismic piping rupture analyses proposed by the licensee should be extended in order to ensure the systematic revision of the rupturing of these pipes, without previous screening by probabilistic estimates.

The CSN evaluation considers that the analyses performed by Ascó NPP with regard to the effects of nearby industries within the framework of the analyses deriving from the IPEEE, and the conclusions of these analyses, are acceptable within the framework of evaluation of this report.

Likewise, as regards fires caused by earthquakes, the evaluation considers that the action proposed by the licensee will contribute to identification and to increasing the robustness of the facility. In those cases in which an adequate seismic margin (0.3g) cannot be demonstrated, the licensee should complete the study with an analysis demonstrating that the potential effects would not affect the safe shutdown of the plant or the fuel pool and its cooling.

- **Flooding**

Licensee's position

Ascó NPP claims to have analysed the external events that might give rise to flooding on the site, these being as follows:

- Maximum Probable Flood (MPF) of the river Ebro for hydrological and meteorological reasons
- Maximum Probable Flood in streams and gullies
- Intense local rainfall at the site itself
- Groundwaters
- Flooding caused by seismically induced rupturing of dams located upstream of the site

The most limiting flooding event is the chain rupturing of the three dams located on the river Ebro upstream of the site. The flooding analyses contemplated in the design basis indicate that in the most unfavourable hypothesis of those analysed, the water would reach a level of 47.7m, which is below the 50.0 m of the plant ground surface level. For the present report, additional dam break analyses have been performed, based on seismic events and flooding, the conclusion being that the maximum level that would be reached on site would be 48.11 m, this leaving a margin of almost 2 metres with respect to the level of the ground surface.

No limit situations have been identified associated with flooding phenomena on the site of Ascó NPP. Nevertheless, the 400kV switchyard is located at elevation 38, as a result of which it is reasonable to assume that if this level were exceeded, all the electrical feeds from this switchyard would be left out of service, causing the tripping of the plant and, with some probability, a complete loss of off-site power.

As an additional measure, the licensee proposes to undertake an analysis of the channelling of flows in gullies close to the site with a view to determining potential improvement actions. Likewise, in the case of penetrations in trenches, the seals will be revised to provide them with a hydrostatic resistance contributing an additional margin.

CSN evaluation

The design bases relating to the different events are included in the Safety Analysis Report and in complementary documents that have updated the information subsequent to the initial plant licence and that have been evaluated and inspected by the CSN.

In the case of flooding as a result of intense local precipitation, no procedures aimed at preventing the possible consequences of this phenomenon are quoted, for which reason it should be included in the final report.

The measures proposed to increase the robustness of the facility against flooding are considered adequate but should be specified in greater detail in the final report.

Finally, the analyses of dam break events and resulting flood levels on site will be checked by the CSN, the hypotheses, input data and methodology applied being revised by means of the corresponding evaluation and inspection processes, which are currently being performed.

- **Other extreme natural phenomena**

Licensee's position

The only natural event that has passed the process of screening, applied in order to rule out those having a negligible impact, has been high winds, the design basis value being 144 km/h. From the analysis of safety-related structures and tanks, the licensee concludes that a safety margin of more than 2.6 times the design wind speed is available.

CSN evaluation

The screening of external events performed to establish the design basis is based on a very low probability of occurrence (10^{-6}), in keeping with the probabilistic methodologies included in the applicable IPEEE standards. In the report submitted, only the occurrence of high winds has been dealt with.

In order to address situations beyond the design basis and determine the safety margins, consideration should be given to other credible external events on the site (such as snow, electrical storms, extreme temperatures, drought, hail, upheaval of the ground and external fires), and these analyses should be included in the final report.

Loss of safety functions

- **Prolonged loss of off-site power (LOOP)**

Licensee's position

Ascó NPP concludes that the off-site feeds are highly reliable and that they provide confidence in the capacity to rapidly recover from a loss of the off-site grid. As regards the on-site feeds, the plant points out that the two Emergency Diesel Generators existing in each group are capable of withstanding a LOOP situation for more than 7 days without any additional support resources available. Furthermore, the licensee mentions the on-going project for the installation of a fifth Emergency Diesel Generator, with the same design and qualification requirements as the two existing at each group and capable of replacing any of them.

CSN evaluation

The LOOP scenario is within the plant design basis, with a coping time of at least 7 days. Consequently, the situation has been evaluated and licensed in previous stages of the lifetime of the plant and its different aspects have been inspected by the CSN.

The off-site electrical feed lines have different points of origin and follow different paths, this independence strengthening the reliability of the supply. The grid operator has procedures for recovery by zones that take into account the preferential treatment to be given to the nuclear power plants. The performance of periodic tests relating to the recovery of off-site power from the hydroelectric station is considered a positive measure.

LOOP with loss of normal back-up sources

Licensee's position

The analysis performed by the licensee underlines the existence of an additional Diesel Generator (GD-3), common to both groups, that is capable of feeding loads such as the hydrostatic test pump, train B class 1E battery chargers, emergency lighting, etc. and allows the loss of off-site power and of the normal back-up sources to be addressed. This generator is located in a separate building from the EDG's and is cooled by an autonomous circuit equipped with its own cooling tower. Activities are on-going to extend the autonomy of this Diesel Generator to more than 7 days and to allow it to be connected simultaneously to both groups, as well as to the cooling of the Spent Fuel Pool.

CSN evaluation

The complete loss of power on and off site (Station Blackout, SBO) is an event beyond the design basis of the operating plants that was incorporated in the Licensing Basis with a coping time of 4 hours. Nevertheless, the Alternative Alternating Current Feed System by means of this DG-3, installed to comply with the standards, was designed for 8 hours of SBO at one of the Ascó NPP groups. The scenario now considered is an SBO in which the coping time of 8 hours considered in the design of DG-3 is extended to more than 7 days and that may occur simultaneously in both Groups. As it is possible to connect DG-3 to both groups, and with the measures proposed to increase autonomy to more than 7 days, the plant will be capable of withstanding this situation for more than 7 days without any additional support. With the support of the aforementioned DG, the direct current and the 120 V alternating current of Train B will be available.

The CSN evaluation estimates that Diesel Generator DG-3 at Ascó NPP may be considered a plant strength, since it is located in a building separate from the EDG's, with different support systems and with autonomous cooling. Likewise, there are no objections to DG-3 being shared by the two groups in the situation indicated, although it would be necessary to carry out suitable checks regarding capacity and the power demanded in the event of the simultaneous connection of both groups.

As regards the capacity of the sources supplying the steam generators and the supply of water to the primary circuit by means of the hydrostatic test pump, the plant has the capacity to address this scenario without any additional support for more than 7 days.

The CSN will review the licensee's new analyses, which will be developed in greater detail in the final report.

- **LOOP with loss of normal and back-up sources and of DG-3**

Licensee's position

The licensee's report indicates that in this situation only the batteries would be available as a source of electrical supply. By design, each of these has a capacity that allows it to feed the associated necessary loads for at least two hours. The report includes a reanalysis of these times, considering more realistic consumptions, and a new strategy for the selective disconnection of loads, the value obtained exceeding 24 hours.

In this scenario, the removal of residual heat from the core is accomplished via the Steam Generators, through discharges to the atmosphere via the relief valves and maintaining inventory by means of the Auxiliary Feedwater Turbine-Driven Pump (AFWTP). Under these conditions it is not possible to maintain primary inventory in the long term due to the leakage expected across the seals of the Reactor Coolant Pumps. The licensee includes an analysis of the times in which uncovering of the core and failure of the vessel and the containment would occur. In view of these analyses, the licensee plans to install portable equipment, available on site in a safe location, to generate electricity to increase autonomy to more than 72 hours and make it possible to provide alternative injection into the primary. A study is under way to specify this equipment, taking into account several hypotheses regarding the availability and/or accessibility of the distribution centres.

CSN evaluation

As regards increasing the autonomy of the batteries, the CSN evaluation considers the use of realistic (best estimate) criteria to be acceptable in the hypotheses to be considered and in the disconnection of unnecessary loads, these to be duly included in procedures and trained. These analyses and the autonomy values obtained will be checked by the CSN, as will the forecasts regarding the portable equipment mentioned by the plant for use within 24 hours. Both the calculations performed to justify the increase in autonomy for each of the batteries and the forecasts regarding the portable equipment mentioned by the plant for use within 24 hours will be checked by the CSN.

The plant has adequately described the equipment foreseen for the SBO scenario without availability of the diesel generator, in which the plant would respond to the situation with the help of the direct current systems: steam generator feed by means of the Auxiliary Feedwater Turbine-Driven Pump (AFWTP) and depressurisation of the SG's, and consequently of the primary circuit, by means of the SG relief valves. Under these conditions it would not be possible to maintain primary inventory in the long term due to leakage across the seals of the Reactor Coolant Pumps.

The CSN evaluation concludes that the forecasts and proposals made by the plant are acceptable for this progress report. The analyses performed to determine time limits will be revised by the CSN.

- **LOOP with loss of all back-up sources and batteries**

Licensee's position

The licensee points out that in this situation the only remaining possibility is the manual operation of the AFWTP and the SG relief valves, and includes an analysis of the time that would be taken to reach a limit situation. As an additional measure to what is described in the previous point, the licensee proposes to bring in portable equipment providing an alternative make-up capacity to the steam generators.

In addition, with a view to improving the capacities of the plant with respect to possible losses of power, the licensee proposes to implement improvements such as the incorporation of portable motor-driven generators capable of providing feed for the hydrostatic test pump, battery chargers or motor control centres, the availability of motor-driven pumps to inject water into the primary circuit and the steam generators, or the incorporation of additional lighting and communication resources, as well as the performance of the corresponding analyses.

CSN evaluation

In this scenario of loss of direct current from the very beginning, the only option open is the manual operation of the AFWTP and the SG relief valves to remove residual heat and delay potential core damage to the extent possible. This manual operation strategy and the feasibility of implementing the improvements contemplated will be checked by the CSN and should be dealt with in greater detail in the final report.

- **Loss of Ultimate Heat Sink**

Licensee's position

Ascó NPP describes the two existing heat sinks. As these are totally independent, the loss of one would not affect the capacity of the plant to reach safe conditions.

In its preliminary report, Ascó NPP mentions the Safeguards Pool, which maintains an inventory of water sufficient to provide feed for the ultimate heat sink for 30 days. Furthermore, it allows water to be channelled to both the Auxiliary Feedwater System and the Spent Fuel Pool by gravity, without the need for any pumping element.

- **Simultaneous loss of primary and alternative ultimate heat sinks**

Although the licensee indicates that the simultaneous loss of both heat sinks is not considered to constitute a credible situation, given the physical layout and independence of the systems transmitting residual heat, this scenario is analysed and it is concluded that it would not lead to a limit situation since the plant would be capable of withstanding the scenario for more than 7 days without external support.

- **Loss of primary and alternative ultimate heat sinks with SBO**

The analysis submitted concludes that the situations that might arise are equivalent to those corresponding to SBO, for which reason the improvement actions coincide with those indicated in the section on this event.

CSN evaluation

For the purposes of this analysis, the licensee considers that two heat sinks are available, one identified as the primary heat sink (system 41, cooled by water from the river Ebro) and the other as the alternative heat sink (system 43, equipped with a water storage pool). The loss of system 41 is within the plant design basis and has been evaluated and licensed in previous stages. The equipment and procedures required to address these situations have been inspected by the CSN on numerous occasions.

The loss of the alternative ultimate heat sink would not in itself cause any plant transient, since it has no function during normal operation. In application of the Operating Technical Specifications, the plant would be taken to Cold Shutdown.

The loss of both ultimate heat sinks would lead to a situation in which the critical systems and components required to maintain safety functions, such as the auxiliary feedwater, steam generator relief valves and hydrostatic test pump, would be the same as those considered in the section on loss of power and, therefore, to a situation similar to LOOP with loss of the emergency DG's. The measures proposed, which are the same as those already considered in the previous analyses, are considered positive to reinforce the robustness of the plant in response to this accident scenario.

As regards the long-term (24 hours or more) operation of the turbine-driven auxiliary feedwater pump, this capacity is not checked in the surveillance tests to which this component is subjected. The licensee should analyse the possibility of carrying out additional tests.

In general the descriptions and assessments provided by the licensee are considered correct and should be completed in the final report.

<u>Accident management</u>

- **Measures for the Management of Severe Accidents affecting the Reactor**

Licensee's position

Like the rest of the plants, the licensee describes the measures in place as regards equipment, procedures and human resources to prevent, mitigate and manage severe accidents. The licensee also describes the use of the guidelines and procedures to be applied as plant conditions degrade.

Furthermore, Ascó NPP proposes a series of actions to increase the robustness of the facility with respect to this type of event. The plant announces that in addition to what is indicated in the general section regarding a new centralised Emergency Support Centre, and when the definition of the new strategies is completed, it will review the suitability of the human resources currently contemplated in its SEP. It also indicates that it will install passive autocatalytic recombiners (PAR) in containment to improve hydrogen control, that it is performing a study to determine the best option for the installation of filtered containment venting, that it is analysing the advantages and disadvantages of allowing water to be injected to containment and the reactor cavity and that it is studying possible strategies to allow for spraying from the exterior to mitigate the release of fission products.

CSN evaluation

Both, emergency operating procedures (EOP) and Severe Accident Management Guidelines, have been incorporated at this plant on the basis of the standards of the Westinghouse owners group (PWROG). These are considered adequate for the performance of their function, as has been corroborated by the CSN through inspections and evaluations.

The actions proposed by the licensee as regards analysis and additional measures for the incorporation of portable equipment to prevent fuel damage are considered positive; in this respect, consideration should be given to the times required for the performance of these actions and to the times available before the limit situations to be avoided are reached. These measures have already been commented on in the sections of this report dealing with the loss of safety functions.

In his report the licensee includes accident management measures for the protection of containment integrity in the event of a severe accident, such as the implementation of Passive Autocatalytic Recombiners allowing hydrogen concentration to be reduced without depending on support systems. As a final level of defence, the licensee also proposes to determine the best option for the installation of a filtered containment venting system, taking into account aspects such as off-site dose and reduction of the source term.

The licensee identifies the equipment and resources available to estimate the quantity of radioactive material released off site in the event of a discharge being necessary to protect the containment, although the analysis should be extended to contemplate the radiological and environmental conditions present in the event of a severe accident.

The CSN evaluation considers that in general the measures described by the licensee are correct and has identified a number of detailed issues that should be dealt with in greater detail in the final report, such as the potential accumulation of hydrogen in other buildings, the treatment of severe accidents in other operating modes, the radiological implications of the emergency response and recovery actions, the availability of instrumentation in these scenarios, dosimetry control and protection resources and lighting and communication conditions, as well as the availability of boron to respond to potential return to criticality events in the measures finally adopted.

- **Loss of spent fuel pool inventory and/or cooling**

Licensee's position

The analysis submitted analyses situations of progressive loss of spent fuel pool inventory due to evaporation, resulting from the loss of cooling, and determines the times available for mitigation actions to be implemented. The licensee does not consider significant leakage from the pool as a result of earthquakes to be credible as the structure of the building and of the spent fuel pool (SFP) is designed for the SSE (0.13 g) and an analysis of seismic margins has been performed that shows that the pool, the steel liner, the gates and their sealing system and the storage racks are capable of withstanding more than 0.3 g.

The process that would take place in the event of loss of pool cooling implies an increase in the temperature of the water to saturation temperature, with the corresponding loss of inventory due to evaporation, this also implying the loss of radiological shielding. If it were not possible to replace the inventory, the process would continue until the level reached the upper part of the fuel assemblies, initiating the process of degradation of the fuel. The time calculated for the water level to reach the upper part of the fuel is 97 hours in normal operation and 41 hours under the worst-case refuelling conditions. In view of these times the licensee claims that there could be no limit situations relating to this problem. Furthermore, one of the existing means for replenishment is from the safeguards pool, which allows for make-up by gravity without the need for active pumping means. Despite this, the licensee is analysing strategies using additional means for make-up to the pool and spraying of the fuel, along with potential improvements to the associated instrumentation.

CSN evaluation

In general the descriptions and assessments provided by the licensee are considered to be correct. The CSN evaluation has confirmed that the licensee has not yet completed his analyses, for which reason the results included in the progress report are not complete (missing among others are those relating to potential improvements to the instrumentation or to the phenomenon known as sloshing, which occurs on the free surface of the pool when it is subjected to agitation). The pending results should be incorporated by the licensee in his final stress test report.

As regards radiological aspects, the CSN is evaluating the dose rates derived from loss of level in the pool and included in the licensee's report, the results of which may imply a revision of the times available for the performance of local manual actions for water replenishment to the pools. The analyses submitted should be completed in the final report with an analysis of the availability and suitability of the instrumentation to be used and of the resources available for the dosimetry control and protection of the workers.

- **Spent fuel storage**

The construction of a Temporary Storage facility for the dry storage of spent fuel, to be located far above the flood level, is currently in the licensing phase. This Temporary Storage facility is designed as seismic category I and is scheduled to start up next year.

4.2.5. ALMARAZ NPP

Extreme natural events

- **Earthquakes**

Licensee's position

The seismic design of the two groups at Almaraz is based on a safe shutdown earthquake (DBE) with a free field horizontal acceleration (PGA) of 0.10 g. The licensee has reviewed the seismic design basis of the plant to determine its current validity, extending the initial period with the catalogue of seismic events that have occurred from 1970 to 17/05/2011 and concluding that it continues to be valid.

In the review of the seismic margins, the licensee indicates that Almaraz NPP has a seismic margin (HCLPF capacity) equal to or greater than 0.21 g, and identifies the plant components with an HCLPF lower than 0.3 g. Also identified is an HCLPF seismic margin of 0.20 g for the confinement integrity of the spent fuel stored in the fuel building, along with an HCLPF seismic margin of 0.3 g for loss of containment confinement integrity. As a result of the analysis the licensee identifies the components that are to be changed or reinforced in order to confirm that the seismic capacity of the plant reaches a level of 0.3 g

The licensee claims to have procedures to address the potential consequences of the earthquake within the design basis, without the need for off-site resources. As regards the internal flooding that might occur as a result of pipe breaks due to an earthquake, the plant indicates that adequate protection against such events is guaranteed.

In addition, and as regards the effect that a seismic event beyond the plant design basis might have on the dam located on the river Tajo in the vicinity of the plant, the licensee has undertaken a structural analysis and has concluded that the dam would maintain its integrity following an earthquake of intensity 0.3 g. Although the results of the structural calculation show that for this earthquake there would be no structural collapse, rupturing or loss of functionality, the possibility of flooding as a result of the dam break with the reservoir filled to its maximum normal level (elevation 315 m) has also been analysed. The conclusion is that in neither of the two hypotheses considered (instantaneous and simultaneous breaking of the dam spillway gates and partial window-shaped break of the dam with a total surface area of 2,500 m^2) would the plant ground surface level (elevation 257.5 m) be reached, the flooding reaching elevation 256.73 m in the worst case.

As regards flooding as a result of seismic activity, the licensee points out that possible sources of internal flooding have been identified from the selection of systems and lines identified in the Flooding PSA. This identification was performed with a view to analysing the seismic margins and inspecting their status as a way of determining the actual conditions of these elements. The licensee also indicates that activities will be carried out to obtain a value as close as possible to 0.3 g, such that the seismic margins of the equipment and structures required to perform safe shutdown functions are around 3 times the design basis earthquake.

CSN evaluation

The seismic design bases of Almaraz NPP are those licensed in the original design of the facility, are included in the Safety Analysis Report and have been evaluated and inspected repeatedly by the CSN. As regards arrangements to protect the plant against the DBE, the report does not make any reference to the existence of the plant Seismic Monitoring System, which should be included in the final report.

The CSN will revise the analyses performed to increase the seismic margin of the plant, carrying out appropriate checks by means of the corresponding evaluation or inspection processes.

The integrity of the Valdecañas dam, located upstream of the plant, has been analysed with respect to an earthquake with a horizontal PGA of 0.3 g, a vertical PGA of 0.2 g and water up to the maximum reservoir elevation of 315 m, the conclusion being that its integrity is maintained. The analysis of stability in the face of extraordinary flooding contemplates the collapse of the dam due to sinking of its foundations, which penetrate 20 metres into the ground, and rupturing of the crown, the result obtained pointing to ample margins against flooding of the plant in both cases. The CSN will check the rupture hypotheses and the calculations performed.

As regards the analysis of flooding as a result of failure of the Valdecañas dam, whatever the cause (seismic or otherwise), the CSN will check the rupture hypotheses used and the flood propagation calculations performed in order to ensure that consideration has been given to all credible hypotheses and that the calculations are adequate.

In relation to floods arising as a result of earthquakes, the CSN considers in its evaluation that the actions taken by the licensee are far-reaching and contribute to the robustness of the facility, but that the scope considered is not clearly identified. The CSN evaluation considers that a wider scope for the analysis should not be ruled out a priori and that it should also contemplate other piping, sources of flooding and non-seismic category I barriers identified in the internal flooding analysis as potentially generating initiating events and affecting the mitigation systems.

The licensee has not addressed the analysis of possible fires resulting from seismic events, and should include this in the final report.

- **Flooding**

Licensee's position

Almaraz NPP has a margin with respect to the maximum flood height calculated in accordance with its design basis, in which consideration is given to a maximum flood with a "return period" of 10,000 years. The plant also indicates that the flood for a return period of ten million years would also be lower than the ground surface level and that the probability of buildings located below this elevation sustaining damage would also be very low for a return period of one million years, for which reason the margins available are considered to be adequate. Despite this, Almaraz NPP proposes to implement a design modification increasing the capacity of the Arrocampo dam drains and another to make the access doors to the blowdown treatment and safeguards buildings watertight. The plant also points out that it is analysing the possibility of improving the leaktightness of the other installations housing safety-related equipment, the capacity to drain the site and the sealing of gallery penetrations.

CSN evaluation

The design bases relating to the different events that might cause flooding of the site are included in the Safety Analysis Report and have been evaluated and inspected on numerous occasions by the CSN.

As regards the new analyses performed, the data provided by the plant require certain additional clarifications, although in any case there is a guarantee that the plant flooding level will not be reached. These clarifications should be incorporated in the final report.

Regarding the analysis of the effect of flooding due to the entry of water via plant ducts located below the level of the ground surface, or to an increase in the water table, the information should be extended upon in the final report. Likewise, the effects of loss of the water table control systems existing at the plant, consisting of active systems with electrical feed, should be analysed.

As regards flooding as a result of intense precipitations, there is no quantification of the time available following activation of the alarm in the Control Room to implement the actions contemplated in the Emergency Plan. This information should be included in the final report and the information on procedures to prevent flooding should be completed.

All the measures proposed are considered to be suitable to contribute to strengthening the response of the plant to external floods.

- **Other extreme natural events**

Licensee's position

The natural events that have passed the screening process designed to rule out those having a negligible effect are torrential rains and strong winds. In his analysis the licensee concludes that there are sufficient margins available with respect to both situations. In this respect it is indicated that the plant would not be affected by precipitations with a frequency of occurrence of once every 10 million years, that the plant structures were designed to withstand wind speeds of 144 km/h and that the maximum annual gust of wind in the period analysed was 136km/h, as a result of which the wind speed established by the design criteria has not been exceeded at any time. The safety factors applied in designing the structures imply available margins of almost 50% for non-seismic buildings and of more than 100% for seismic buildings. Despite this, the licensee plans to analyse the feasibility of undertaking improvements to the roofs and terraces.

CSN evaluation

The screening of off-site events performed to establish the design basis is based on a very low probability of occurrence (10^{-5}), in accordance with the probabilistic methodologies included in the applicable IPEEE standard. The report submitted deals only with the occurrence of torrential rains and strong winds (in the final report torrential rains should be included in the section on flooding).

In order to address situations beyond the design basis and determine safety margins, consideration should be given to other credible external events at the site, such as snow, lightning strikes, high temperatures, drought, freezing conditions, hail and external fires. These analyses should be included in the final report.

Loss of safety functions

- **Loss of off-site power (LOOP)**

Licensee's position

Almaraz NPP concludes that the off-site electrical feeds are highly reliable and provide a high degree of confidence as regards rapid recovery from a loss of off-site power. As regards the on-site feeds, it points out that each group has 2 diesel generators (plus one that is shared), these being seismically qualified and having nuclear safety class (Class 1E) electrical requirements. The gasoil tanks have sufficient capacity to feed one diesel generator in each group for more than 7 days, or 10.5 days if there were no passive failure in one of the tanks.

The licensee points out that at least seven days operating capacity is available in the event of LOOP.

The plant indicates that several tests have been performed on the supply to Almaraz NPP from the hydroelectric stations, guaranteeing the availability of electricity in a very short space of time. With a view to adopting a systematic approach to these tests, the licensee plans to perform them periodically and draw up a procedure.

CSN evaluation

The LOOP event is within the plant design basis, with a coping time of seven days, and the measures to respond to this scenario have been evaluated and inspected by the CSN.

The off-site lines have different points of origin and follow different paths, this increasing the reliability of the supply. The operator of the grid has procedures for recovery by zones that take into account the preferential feed for nuclear power plants. Furthermore, the proposal that periodic tests be performed on the recovery of off-site feed from the hydroelectric plants will improve the reliability of recovering off-site feed.

The final report will confirm the existing capacities of the lubrication and cooling systems (oil and water) to ensure the aforementioned seven-day period of availability.

- **LOOP with loss of normal back-up sources**

Licensee's position

The plant has a fifth diesel generator with all autonomous services, including air cooling and batteries, and with the same capacity, design requirements and qualification as the other four. This generator is designed to act as a substitute for any of the others by means of a quick interconnection system.

With a single group in the SBO situation, DG5 would be aligned to this group, recovering the emergency electricity supply and allowing both groups to be taken to safe shutdown and maintained in this situation in the long term. With both groups affected by SBO, DG5 would be aligned alternately to both, this allowing for the use of the safeguards systems in one group and for the batteries to be kept charged in the other for control of the Auxiliary Feedwater Turbine-Driven Pump (AFWTP) and steam generator relief valves.

CSN evaluation

In the event that both groups were affected by SBO, the licensee proposes the alternate alignment of DG5 to each of them. The CSN evaluation considers Almaraz NPP DG5 to constitute a plant strength, since it is physically separate from the other EDG's, has different support systems and is air cooled. The incorporation of this 5th DG was the subject of a specific licensing process.

The CSN evaluation has no objections to the alternate alignment of DG5, although it is considered that it would be advisable for the plant to analyse the feasibility of coupling this DG to both groups simultaneously, which is not possible with the current design due to the existing interlocks.

- **Station blackout (SBO)**

Licensee's position

In the event of a total loss of alternating current power, the plant is licensed to respond for at least 4 hours with only direct current. In this respect, the affected groups would initiate primary system cooldown by means of the SG relief valves and the AFWTP. The plant indicates that the actual time available before the depletion of the battery feeding the AFWTP (battery B) would be 7 hours and 50 minutes, and that it also has an alternative source, a dedicated battery, that would provide feed for an additional 7 hours and 20 minutes.

In addition, the auxiliary feedwater turbine-driven pump could also be operated manually without d.c. feed, which would make it possible to maintain feed to the steam generators as long as a water supply to the said turbine-driven pump were available. On the basis of realistic calculations, the capacity of the storage tanks is more than 24 hours.

Furthermore, with a view to improving the capacities of the plant in response to possible losses of power, the licensee proposes the implementation of measures such as portable equipment to inject into the primary circuit and provide water for the steam generators, the incorporation of improvements in the instrumentation and lighting and communications systems and performance of the corresponding analyses.

CSN evaluation

The Station Blackout (SBO) scenario was incorporated in the Licensing Basis of Almaraz NPP assuming that the total loss of alternating current supply takes place in one only of the two groups and that considering a coping time of 4 hours.

The licensee considers increasing the autonomy of the batteries by disconnecting unnecessary loads in accordance with procedures. The CSN will carry out a detailed evaluation of the calculations performed with respect to battery B. No information is provided for the battery on train A (which does not participate in operation of the turbine-driven pump), this to be included in the final report.

The CSN evaluation considers that the final report should confirm the existence of on-site resources or the provision of light equipment from the exterior in order to maintain the operability of the batteries (at least battery B) for at least 72 hours, as well as the availability of water supply to the steam generators.

As regards the feasibility of operating the turbine-driven pump with manual control, the fact that this has been tested in one group and that this test has been satisfactory should be considered a strength. Consideration will be given to the need for this same test to be carried out in the other group. The CSN will perform additional verifications of this test.

The improvement actions proposed by the licensee are considered adequate. Particularly noteworthy is the plan to make portable instrumentation available, along with an alternative pump for injection to the primary circuit to make up the inventory lost due to leakage across the seals.

In general, the plant provides partial information in relation to the analysis of time limits; this should be completed in the final report with specific details on the hypothesis of leakage across the seals of the reactor coolant pumps, considered in the analyses to determine the time to uncovering of the core.

As regards the situation of LOOP with the loss of all back-up sources and batteries, the licensee should extend upon the analysis performed, additional to the test already performed on the auxiliary feedwater turbine-driven pump.

- **Loss of ultimate heat sink (UHS)**

Licensee's position

Almaraz NPP describes the two heat sinks existing at the plant and that may be used by the essential services water (ES) system. By itself, the loss of one of these would not affect the capacity to reach safe conditions. If both were lost, or the ES, the situation would be similar to that described for LOOP with loss of the normal back-up sources.

- **Loss of ultimate heat sink combined with SBO**

In this case the situation would be similar to that described for SBO without DG5 available.

CSN evaluation

The loss of either of the two pools is within the plant design basis and has already been evaluated; the equipment and procedures required to respond to these situations have been inspected by the CSN on numerous occasions.

The total loss of the ultimate heat sink in different scenarios leads to the situations analysed in the section on loss of power. The measures proposed by the licensee in this section are considered positive to strengthen the robustness of the plant in response to these accident scenarios.

As regards the long-term operation (24 hours or more) of the auxiliary feedwater turbine-driven pump, this capacity is not checked in the surveillance tests to which this component is subjected. The licensee should analyse the possibility of performing additional tests.

In addition to what is indicated by the licensee in this section, loss of the ultimate heat sink would lead to the loss of spent fuel pool cooling, which is analysed below.

<u>Accident management</u>

- **Measures for the management of accidents affecting the reactor**

Licensee's position

Like the rest of the plants, the licensee describes the measures existing in relation to equipment, procedures and human resources to prevent, mitigate and manage severe accidents.

Almaraz also analyses the different strategies contained in its SAMG's and their capacity to protect the containment and mitigate off-site releases, concluding that with the resources existing and with what is proposed in previous chapters, the plant has sufficient capacity to respond to severe accidents.

In any case, Almaraz proposes different activities to increase the robustness of the facility in response to this type of events. Thus, in addition to what is indicated in the general section regarding a new centralised Emergency Support Centre, following the definition of the new strategies, it announces that it will review the suitability of the human resources currently described in its Site Emergency Plan, taking into account also the possibility of the event affecting both groups. It also indicates that it plans to install passive autocatalytic recombiners (PAR) inside containment to improve hydrogen control in the event of a severe accident, even in the event of a prolonged SBO, and that it is analysing the different possibilities to be able to reduce the pressure in containment during accidents of this type.

CSN evaluation

The licensee proposes additional reinforcement measures relating to portable equipment to prevent damage to the fuel. All these measures are considered positive to prevent fuel damage.

The measures proposed by Almaraz NPP for severe accidents in relation to the instrumentation and the installation of PAR's are considered positive.

As regards the depressurisation of containment, the licensee plans to carry out a study to determine the feasibility of installing a filtered containment vent. In his assessment, the licensee should consider the beneficial effects of installing a filtered containment vent, as well as the pressures at which this is expected to be used.

In relation to the measures available to estimate the quantity of radioactive material released off site if a discharge has to be performed to protect the containment, the licensee should carry out this analysis in greater detail.

As regards containment and reactor cavity flooding strategies, in his final analysis the licensee should contemplate possible improvements, taking into account the important equipment and instrumentation that would be lost.

There are other aspects that should be completed in the final report, such as the potential accumulation of hydrogen in other buildings, the treatment of severe accidents in other operating modes, the radiological implications of the emergency response and recovery actions, dosimetry control and protection resources, the availability of instrumentation in these scenarios and lighting and communication conditions, as well as the availability of the equipments participating in SAMG strategies to fulfil their function in the event of earthquake and/or flooding and the availability of boron to address the potential for a return to criticality in the measures finally adopted.

- **Loss of spent fuel pool inventory and/or cooling**

Licensee's position

The analysis submitted details the different systems available at the plant to cool the pool and provide inventory make-up if necessary, and also points out that heat removal from the pool is guaranteed without the need for action and in the worst-case scenario for longer than 60 hours.

Despite this, and in order to increase the robustness of the plant, the licensee plans to bring in portable equipment suitable to replenish the inventory of water in the pool, as well as portable instrumentation and means to spray the fuel assemblies in the pool.

CSN evaluation

In general, the descriptions and assessments provided by the licensee are considered to be correct.

The CSN evaluation has shown that the licensee has not yet completed his analyses and, has not, therefore, included in his progress report the complete results (missing among others are the potential improvements to the instrumentation or the phenomenon of sloshing (a movement that occurs on the free surface of the pool when it is subjected to agitation); these items should be incorporated by the licensee in his final stress test report.

As regards radiological aspects, the CSN is evaluating the dose rates deriving from loss of level in the pool and included in the licensee's report, the results of which may imply revision of the times available for performance of local manual actions to replace the water in the pools. The analyses submitted should be completed in the final report with analysis of the availability and suitability of the instrumentation to be used, as well as the dosimetry control and protection resources for the workers.

The measures proposed by the licensee are considered positive and are expected to be dealt with in greater detail in the final report.

4.2.6. SANTA MARÍA DE GAROÑA NPP

Extreme natural events

- **Earthquakes**

Licensee's position

Within the framework of the Systematic Review Programme (SEP, 1983), a value of 0.10g was established for the safe shutdown earthquake (SSE). In the context of the stress tests the seismic data considered have been extended, including those relating to the period 01.01.1983 to 31.07.2011, this having confirmed the validity of the SSE value established in the licensing basis.

The report from Santa María de Garoña NPP concludes that the plant has sufficient capacity over and above the SSE to guarantee the safe shutdown of the reactor and maintenance of the containment and fuel pool confinement function. A "seismic margin" of 0.30g is available, except in the case of the Condensate Tank, the margin of which is limited to 0.17g, and emergency bus minimum voltage relays and pool spillover tanks, whose margin is limited to 0.28g. These components will be the subject of a design modification to achieve a margin of 0.30g in all the systems required to achieve safe plant shutdown.

The licensee has also analysed the issue of a beyond the design basis earthquake possibly affecting the Ebro dam, located at a distance of 70km as the crow flies from the plant. The analysis has concluded that this dam would maintain its integrity in the event of an earthquake of 0.358 g, this explaining why the hypothesis of its rupture was not considered as part of the plant design basis.

CSN evaluation

The current licensing bases for the seismic design of Santa Mª de Garoña NPP have been evaluated and accepted by the CSN and have been inspected repeatedly by the Council as part of its supervision programmes. The review performed considering earthquakes from 01.01.1983 to 31.07.2011 confirms the SSE value established and is considered acceptable.

Prior to the "stress tests", the licensee had already accredited a seismic margin of 0.17 g for the plant, this limitation being due to the condensate storage tank. The extension of the seismic margin analyses proposed is considered acceptable. The results will be verified by the CSN.

As regards rupturing of the Arroyo dam (Ebro dam) due to an earthquake, the licensee provides a seismic margin value (capacity before rupturing) of 0.358 g. The hypotheses and calculations performed will be verified by the CSN, along with the rest of the analyses justifying that the potential floods caused by earthquakes would remain below the intake structure and that the plant would have all the safety functions required to go to safe shutdown.

As regards the effects of internal events arising as a result of earthquakes, such as internal flooding or fire, the licensee has not included any analyses in his report. The CSN considers that the licensee should perform such analyses, taking into account the observations made in this report in relation to the studies submitted by other plants, and include them in his final report.

- **Flooding**

Licensee's position

The design of the plant contemplated a Probable Maximum Flood (PMF) with increases in flow in the river Ebro possible reaching 2,502m^3/s, as a result of which elevation 515.72m would be reached; this would not affect the safe shutdown equipment (ground surface level: 518.0m and elevation affecting the Intake Structure (516.5m). Also analysed has been the complete and instantaneous rupturing of the dams located upstream of the plant. The flows obtained, combined with the 50% of the PMP, produce levels of flooding that do not exceed elevation 516m, and do not, therefore, affect any of the vital elements of the facility. The licensee indicates that the chain rupturing of these two dams has not been considered since the total spill capacity of the dam closest to the plant is greater than the flood wave.

Within the scope of the stress tests, and in order to identify the existing safety margins for these dams, Garoña points out that the issue has been re-assessed using updated methods and more accurate models, the on-site flow values being lower than those obtained in the design bases.

Finally, and as regards the potential rupturing of the Ebro dam, Garoña has performed an analysis of its consequences on the basis of realistic hypotheses, concluding that the flooding level would not exceed elevation 515.75m, not therefore affecting the vital areas of the facility, and that the time elapsing prior to the maximum level being reached would be longer than 26 hours (the course of the river measures 158 km from the dam to the plant), this allowing preventive measures to be taken in the hypothetical case of rupturing.

CSN evaluation

The design bases relating to the different events that might cause flooding of the site are included in the Safety Analysis Report and have been evaluated and inspected by the CSN on numerous occasions. As regards the new analyses performed, the CSN will verify the hypotheses and calculations used by the licensee to conclude that the possible flood levels would not affect the vital areas of the facility.

The document submitted does not include the analysis of the possible effects of flooding due to intense local precipitations, nor the estimation of margins with respect to the design of the rainwater or roofs drains networks. Neither is there any analysis of the potential impact of rises in groundwater levels, as a result of which the final report should include these aspects.

The licensee has not identified the actions that would be taken in the event of the extraordinary rupturing of the dams and does not identify the corresponding action procedures, as a result of which this information should be completed in the final report.

Additionally, the CSN considers that the licensee should complete his studies by analysing the possible consequences for the intake structure of a massive entrainment of algae or other materials as a result of the floods considered.

- **Other Extreme Natural Phenomena**

Licensee's position

The licensee has analysed the possible occurrence of events produced by other natural phenomena of external origin, identifying the loads due to winds and the low level of the river as a result of rupturing of the Sobrón dam as being the most significant. Following assessment of the maximum foreseeable wind loads, it was concluded that the design of the structures contemplated values higher than those obtained. As regards the low river level, the licensee indicates that it had been observed that given the configuration of the water intake, the long-term removal of residual heat was not questioned, since the Emergency Services Water system would remain operable.

The licensee has also analysed the snow load event, concluding that the probability of the dimensioning of the roofs being exceeded is so low that it does not warrant further analysis. As regards drought and high temperatures, and following the design modifications performed in 2007, in which the cooling of the pumps rooms was made independent from the river water, Garoña concludes that plant safety is not compromised.

CSN evaluation

The screening of external events performed to establish the design basis is based on a very low probability of occurrence (10^{-5} per year), in accordance with the probabilistic methodologies included in the applicable IPEEE standard. The report submitted has dealt with the occurrence of strong winds, low water level in the river, snow, drought and high temperatures.

In order to address beyond design basis situations and determine safety margins, consideration should be given to other credible external events on the site, such as electrical storms, freezing conditions, hail or external fires. These analyses should be included in the final report.

<u>Loss of safety functions</u>

- **Prolonged loss of off-site power (LOOP)**

Licensee's position

The licensee concludes in his report that the off-site feeds are highly reliable and that they provide confidence in the capacity to rapidly recover from a loss of the off-site grid. As regards the on-site feeds, the plant points out that the two Emergency Diesel Generators existing are capable of withstanding a LOOP situation for 8 days without any additional support resources available and without taking into account the fuel existing in the basic tank and day tank. These generators are air cooled, as a result of which they do not depend on the main heat sink.

The preferred method for cooling of the fuel in the LOOP situation is by using the Isolation Condenser, since it does not give rise to a reduction of the inventory of water in the reactor and does not contribute heat to the Suppression Chamber; thus, as long as the supply of water to the shell of the isolation condenser is maintained, reactor cooling is ensured. The sources of supply of water to the isolation condenser available following a loss of off-site power and allowing its continued operation are the Condensate Transfer System and the fire-fighting system, which is seismic in design. At its maximum level the condensate storage tank contains sufficient water for cooling of the reactor for more than 7 days. Furthermore, there are other cooling methods that would make use of the systems available during LOOP.

CSN evaluation

The possibility of a LOOP is within the plant design basis, and autonomy of 7 days is available with the operation of the diesel generators. This scenario is included in the applicable licensing documents and the equipment and resources necessary to respond to it have been inspected by the CSN on numerous occasions during the lifetime of the plant.

The off-site electrical feed lines have different points of origin and follow different paths, this independence strengthening the reliability of the supply for events such as that postulated (LOOP). The grid operator has procedures for recovery by zones that take into account the preferential treatment to be given to the nuclear power plants. The performance of periodic tests relating to the recovery of off-site power from the hydroelectric stations proposed by the licensee is considered a highly positive measure, and it is considered advisable that they be implemented in the near future.

The two emergency diesel generators are air cooled, as a result of which they are independent from the ultimate heat sink.

In view of the above, the CSN considers that the expected response of the plant in the event of LOOP would be safe and as planned.

- **LOOP with loss of normal back-up sources (SBO)**

Licensee's position

Garoña indicates that it has not been necessary to incorporate additional alternating current back-up sources in the design since there are alternating current systems capable of ensuring residual heat removal.

The preferential systems for fuel cooling in this case are the Isolation Condenser (IC) and the High Pressure Coolant Injection System (HPCI). Both depend on direct current for their operation. The HPCI uses the Condensate Storage Tank as its preferential source of water. The HPCI would make up for the loss of inventory from the vessel by short and intermittent start-ups widely separated over time. The use of the HPCI to recover the level in the vessel may be replaced with water injected via the diesel fire-fighting pump, following depressurisation. The supply of water to the shell side of the IC is guaranteed for at least 24 hours by the autonomy of the diesel fire-fighting pump.

In the past the plant included a design modification to allow for gradual opening from the control room of the valve that leads to the entry into service of the Isolation Condenser.

The instrumentation required for the monitoring of the fundamental vessel and primary containment parameters is fed from busses having a UPS with back-up d.c. batteries providing an autonomy of at least 4 hours, which might be extended to 24 hours by disconnecting loads in accordance with the applicable operating procedures, and to 32 hours by means of additional actions.

The licensee proposes the following improvements to increase the autonomy and robustness of the facility in addressing SBO:

- As the use of the Isolation Condenser is the preferred method for cooling of the fuel in the reactor, it is considered advisable to reinforce the current arrangement through an additional feed capacity from the Condensate Tank by means of one of the condensate transfer pumps fed by a motor-generator group specifically set aside for this purpose or by means of a motor-driven pump of equivalent capacity.
- The use of a motor-generator group would make it possible to feed the "J" Motor Control Centre (or a section of thus MCC) located in the turbine building, which feeds one of the condensate transfer pumps, Essential Bus A and 125 V d.c. chargers "A" and "C".

CSN evaluation

The Station Blackout (SBO) scenario was incorporated in the plant licensing basis considering a coping time of 4 hours. As regards the two options considered possible in RG 1.155 (independence from alternating current, availability of an alternative alternating current source), the Garoña plant opted for the first, based on the use of d.c. sources for electrical feeds.

The licensee's plans to extend the duration of the batteries to 24 hours, by disconnecting unnecessary loads, and the subsequent connection of the back-up battery to extend the autonomy to 32 hours, are considered acceptable, although it would be important to complete this with the improvement action proposed, consisting of adding a motor-generator group allowing for the feed of battery chargers "A" and "C", in addition to one of the condensate transfer pumps and Essential Bus "A" (which feeds the instrumentation via a transformer). The CSN plans to review the hypotheses and estimates performed to justify the extended lifetime of the batteries, as well as the action procedures to be used, during the course of an inspection.

As has been indicated in the case of LOOP, the characteristics of the plant with the existing design (i.e., even without the improvement actions foreseen for implementation) already imply strengths, since the two diesel generators are air cooled and are located above the flood level, as are the plant direct current busses and batteries. Furthermore, it is possible to connect the 125V d.c. battery to the essential bus of the corresponding train, thus increasing the guarantees of instrumentation availability.

As regards analysis of a LOOP situation with loss of all back-up supplies and batteries, the licensee does not analyse this case, which is not required in the ENSREG Stress Tests document. As this case may be considered as being one of the lessons learned from the Fukushima event, the CSN considers that Garoña should complete its analysis in this respect.

In this progress report, the plant does not explicitly refer to the times at which the different milestones of the scenarios contemplated would occur. It is expected that these will be included in the final report.

It is concluded that the assessments and proposals made by the plant are acceptable for this progress report phase.

- **Loss of ultimate heat sink**

Licensee's position

In his report the licensee describes the characteristics of the plant's Ultimate Heat Sink, underlining certain systems that do not depend on it for cooling: emergency diesel generators, isolation condenser and essential chilled water systems cooling the control room, the electrical equipment rooms and the low pressure ECCS pump rooms.

- **Loss of Primary and Alternative Ultimate Heat Sinks, with SBO**

In this situation, the system that allows for core cooling and residual heat removal is the HPCI, along with the occasional operation of containment venting (its use requires two containment venting operations in the first 72 hours). This venting is performed prior fuel uncovering and, therefore, without any generation of hydrogen or core damage, as a result of which there will be little impact off site.

The licensee points out that this is the most demanding scenario analysed within the context of the stress test report and that, even so, the plant would maintain its reactor cooling capacity with the resources available and without off-site support for the first 24 hours.

Additionally, with a view to improving the capacities of the plant in response to possible losses of power and of the final heat sink, the licensee proposes to implement the following improvements: inclusion of the hydroelectric plants off-site power supply test in procedures, availability of a motor-generator group to feed the motor control centre that supplies the condensate transfer pumps and battery chargers, availability of an autonomous motor-driven pump as a back-up to the fire protection system and performance of the corresponding analyses.

CSN evaluation

In general the descriptions and assessments submitted by the licensee are considered to be correct; however these analyses do not cover the design and operational actions contemplated to avoid loss of the intake structure, as a result of which this information should be included in the final report.

The measures proposed by the licensee are considered to be positive to reinforce the robustness of the plant in response to this accident scenario.

In this progress report, the plant does not explicitly refer to the times at which the different milestones of the scenarios contemplated would occur. It is expected that these will be included in the final report.

In addition to what is indicated by the licensee in this section, the loss of the ultimate heat sink will also affect the capacity to cool the spent fuel pool. This issue is analysed in another section of this report.

Accident management

- **Measure for the Management of Severe Accidents affecting the reactor**

Licensee's position

Like the rest of the plants, the licensee describes the measures in place as regards equipment, procedures and human resources to prevent, mitigate and manage severe accidents. The licensee also describes the use of the guidelines and procedures to be applied as plant conditions degrade.

In concluding its analysis, Garoña proposes a series of different actions to increase the robustness of the facility in responding to this type of events. Thus, in addition to what is indicated in the general section regarding a new centralised Emergency Support Centre, and when the definition of the new strategies is completed, it will review the suitability of the human resources currently contemplated in its Site Emergency Plan.

Furthermore, the licensee plans to incorporate a series of improvements, among them improvement of the design of the Direct Containment Venting system, collaborating with the BWROG in this analysis and implementing the actions proposed, to develop a procedure for the manual opening of the Direct Containment Vent line valves, to install recombiners in those areas of the Reactor Building in which hydrogen accumulations may occur, and to analyse the possibility of installing a containment atmosphere filtering system complementary to the action of the Torus.

CSN evaluation

In general, the descriptions and assessments submitted by the licensee are considered to be correct, as are the measures proposed. However, there are certain aspects that have been identified that should be completed in the final report, these being listed below.

As regards measures to eliminate the possibility of fuel damage in high reactor vessel pressure sequences, the licensee does not indicate whether there are additional measures available for scenarios in which emergency depressurisation is not possible.

As regards containment flooding strategies, the licensee describes the possibilities existing in the SAG's. It is considered that the licensee should analyse in greater detail their feasibility and the availability of the equipment necessary for extreme situations, along with the possibility of implementing additional improvements.

In relation to containment venting improvements, the analysis should consider the beneficial effects of installing a filtered containment venting arrangement, such as for example the reduction of off-site releases in the event of a severe accident and the reduction of doses in other buildings and affecting the performance of recovery or mitigation measures.

The licensee identifies the equipment and resources available to estimate the quantity of radioactive material released off site in the event of having to perform such a release to protect the containment, but should extend the analysis to contemplate the radiological and environmental conditions present in severe accidents.

As regards the relief valves (RV) and relief-safety valves (SRV), the licensee describes their support systems. The CSN evaluation considers that there should be a more detailed analysis of their availability in the event of a prolonged SBO, along with the feasibility of implementing improvements capable of extending their actuation time.

The estimation of the limiting times for severe accident scenarios in different accident sequences and the times required for performance of the manual actions and portable equipment actuations proposed should be completed in the final report.

There are other aspects that should be completed in the final report, such as the treatment of severe accidents in other operating modes, the radiological implications of the emergency response and recovery actions, the availability of instrumentation in these scenarios, dosimetry control and protection measures, lighting and communications conditions and the availability of the equipment participating in SAMG strategies to fulfil their function in the event of earthquake and/or flooding and the availability of boron to address the potential for a return to criticality in the measures finally adopted.

- **Loss of spent fuel pool inventory and/or cooling**

Licensee's position

The analysis submitted analyses the progressive loss of inventory from the fuel pools due to evaporation and as a result of loss of cooling, determining the times available for the performance of mitigation actions.

The analyses performed by Garoña indicate that in the worst case the minimum time available to the onset of boiling from a situation of power operation would be 44 hours as from the loss of pool cooling, and 9 days until the level dropped to 2 metres above the spent fuel (radiological shielding). If this were to coincide with all the fuel in the pool, with the latter isolated from the reactor cavity, boiling would begin after 11 hours and the level of 2 metres above the fuel would be reached after 56 hours.

The licensee plans to carry out an additional improvement consisting of installing an autonomous motor-driven pump to be able to replace the inventory of water in the pool.

CSN evaluation

In general, the descriptions and assessments provided by the licensees are considered correct, and the measure proposed will contribute to reinforcing the capacities of the plant to respond to this type of events.

The CSN evaluation has confirmed that the licensee has not yet completed his analyses, for which reason the results included in the progress report are not complete (missing among others are those relating to potential improvements to the instrumentation or to the phenomenon known as sloshing, which occurs on the free surface of the pool when it is subjected to agitation). The pending results should be incorporated by the licensee in his final stress test report.

As regards radiological aspects, the CSN is evaluating the dose rates deriving from loss of level in the pool and included in the licensee's report, the results of which may imply a revision of the times available for local manual actions to replace the water in the pools. The analyses submitted should be completed in the final report with an analysis of the availability and suitability of the instrumentation to be used, as well as of the dosimetry control and protection measures for the workers.

4.2.7. JOSE CABRERA NPP (IN THE DISMANTLING PHASE)

Extreme natural events

- **Earthquakes**

Licensee's position

The fuel is in dry storage, in the passive cooling HI-STORM 100Z casks system, which is installed on a foundation slab. The overall assembly constitutes the plant Individualised Temporary Storage (ATI) facility. The seismic design of the José Cabrera nuclear power plant was defined by the safe shutdown earthquake (SSE), of 0.07 g, and therefore the value of its DBE should be that of the SSE for the site (0.07 g). However, the structural assessments were performed for an earthquake of 0.25 g. The methodology used to establish the DBE of the ATI facility arises from the standardised alternative allowed by 10CFR72.103 for sites with relatively low values of seismicity, this being the case for the said facility.

The storage system is passive, has appropriate safety margins and does not require any components or systems to perform its safety functions. It provides confinement, shielding against radiations, criticality control and the passive removal of heat from the spent fuel. There are no active components and no monitoring systems are required to guarantee the performance of the aforementioned safety functions. There are no structures, equipment or components in the vicinity of the ATI facility that might have any indirect effects deriving from the DBE affecting the safety of the installation.

Partial safety margins are determined for the support slab, ranging from 1.13 to 2.44 and guaranteeing a highly conservative design. Loss of adherence and the onset of sliding of the casks occur with a horizontal PGA of 0.28g. Likewise, for a vertical PGA half the horizontal, possible tipping would occur with a horizontal PGA of 0.55g. The structural analysis of the slab identifies a guaranteed structural capacity above 0.25g and allows this to be assessed with a minimum value identical to that for loss of friction, i.e. 0.28g.

CSN evaluation

The Safety Analysis Report points out that the standard earthquake indicated in 10 CFR 72.103 has been considered as the DBE for the ATI facility; that is to say, the supporting slab for the storage system has been designed with the spectra included in USNRC RG 1.60, standardised to an acceleration of 0.25g, this having been verified by the CSN during the licensing process.

It is indicated that there are no SSC's in the vicinity of the ATI facility that might produce indirect effects on the facility in the event of an earthquake. However, the flooding analysis postulates that the rupturing of the two drinking water storage tanks, located at a distance of some 300 metres from the facility, might flood its site. This should be clarified in the final report.

- **Flooding**

Licensee's position

The normal level of the river Tajo as it passes the plant corresponds to elevation 599.8m, and the design basis flood (DBF) may be considered as being at elevation 604. The ATI facility is located on elevation 628m, far above the level of the DBF, and also above the maximum level that might be reached in the event of rupturing of the dams located upstream of the site (Buendía and Bolarque), which according to the results of the analyses performed would reach 623m or 626m, depending on the conservatism of the calculation model used. As an extreme case, the rupturing of the dams located upstream of the site has been assumed and analysed deterministically, not simultaneously but with a difference in time such that the wave produced by both rupture events would produce a total maximum flow of 134,000 m^3/s. The analysis was performed using a simplified (conservative) model. In this case, elevation 629m would be reached in the area of the ATI facility, affecting it to a maximum depth of one metre. Given the topography of the zone, the ATI facility would be flooded at most for a few hours. The velocity in the area of the ATI facility would be low and would not cause any instability of the casks.

In the most extreme case of rupturing of all the dams located upstream, a cask might tip over but would not lose its safety conditions or suffer any mechanical damage. The ventilation ducts of the modules might also become plugged with mud. Both situations are described below. The licensee indicates in his report that loss of access is not foreseen and that even in the extreme case of all of the routes being unavailable, a provisional access might be provided quite simply by opening the double perimeter fence.

The improvement actions proposed are coordination with the operators of the dams to facilitate the evacuation of the personnel as quickly as possible (the extreme flood covers the disused plant) and location of the auxiliary cleanup equipment in the highest area of the site.

CSN evaluation

The updated study of rupturing of the dams gives a flood level of 626.7m in the worst case, this being 1.3m below the site of the ATI facility (elevation 628m). Also analysed is the rupturing of two water tanks located 315 metres from the facility, this producing a depth of 14.8 metres and a velocity of < 3.2m/s, as a result of which the ATI would not be affected. Also analysed is the rupturing of the dams located upstream of the site, with a time difference between them such that the waves produced would coincide at the site of the ATI facility; this gives a flow that would reach elevation 629m, the ATI facility thus being flooded to a maximum depth of one metre. Given the topography of the zone, the ATI facility would remain flooded at most for a few hours.

Likewise, as a result of the worst extreme event scenario, the licensee identifies three bounding situations that are described in the following section, along with the additional resources foreseen.

In his final report the licensee should take into account the drainage of the site of the ATI facility and its removal capacity, and estimate the maximum time during which the said facility would be flooded in the postulated cases of flooding.

- **Other Extreme Natural Phenomena**

The licensee points out that the ATI facility is designed to withstand small or large projectiles caused by hypothetical tornados, although these are not foreseeable in the area, and also that a detailed study has been made of a forest fire under pessimistic conditions, in which respect it is not foreseen that temperatures in excess of those acceptable might be reached or, therefore, that any ATI facility safety function might be lost.

In the evaluation performed, no weaknesses have been identified with regard to other extreme natural events, this being acceptable for the CSN.

Loss of safety functions

- **Total loss of off-site power**

All the safety functions of the ATI facility are ensure passively, as a result of which they would not be affected by the total loss of electrical power.

- **Other relevant situations**

Licensee's position

The report from José Cabrera has considered three bounding conditions independent from their underlying causes:

- Complete and long-lasting plugging of all the ventilation ducts
- Tipping of a cask
- Burial of a cask

The licensee points out that none of the three situations is considered credible at the site, although the complete plugging of the ducts might occur as a result of the mud entrained by an extreme flood and tipping might occur due to the effects of a beyond design basis earthquake. As regards burial under rubble, the licensee considers this to be less credible since there is no structure above or close to the modules and, in view of the topography of the zone, landslides are not foreseen.

In relation to these situations, the report analyses the necessary recovery actions and the times available for their performance.

In view of the results obtained from the analyses, the licensee plans to incorporate a series of improvements, among them the following:

- Study of actions deriving from the seismic surveillance procedures in relation to the beginning of contingency procedures.
- Possible improvement of coordination with the upstream dams, with a view to protecting the plant personnel.
- Study of methods for the righting of tipped casks.
- Reinforcement of training for the unblocking of ducts using available equipment.

CSN evaluation

The CSN evaluation considers that none of the three situations contemplated (plugging of ducts, tipping and burial of a cask) is to be expected as a result of the design basis accidents for the facility (earthquake, flooding, extreme thermal conditions, strong winds). The licensee has re-assessed the performance of the HI-STORM 100Z System taking into account the heat load generated by the fuel as of June 30th 2011, in which respect the margins to the limit situations improve with respect to what is calculated in the licensing studies.

The updating of the heat load also modifies the results of the analysis of complete and long-lasting obstruction of the ventilation ducts with respect to those reviewed by the CSN in the licensing process. The result of the analysis carried out by the licensee with this updated heat load increases the time available for the implementation of corrective actions to one month.

The licensing process for the HI-STORM 100Z System verified that the behaviour of the assembly regarding potential tipping agrees with what was expressed by the licensee, as a result of which the licensee's conclusions are thought to be adequate.

The accident consisting of burial under rubble is the most limiting for the cask from the thermal point of view, since the mechanism of passive cooling might be lost. The licensee determines a time limit of 5.5 days for the burial under rubble accident and specifies the corrective actions and available resources that would reasonably allow the situation to be put right prior to reaching this limit. The CSN will verify the data submitted by the licensee with regard to the residual heat of the fuel assemblies considered, along with the analyses updated with the new data.

Evaluation of the resources available to the licensee to address the situations postulated will be carried out once the detailed analysis of the improvement actions currently under study by the licensee is provided, in the final report.

5.-CONCLUSIONS

The reports submitted by the licensees are preliminary reports; the analyses continue and the CSN is carrying out additional checks of the responses presented by the licensees or of detailed aspects contained in the information submitted. The following preliminary conclusions may be drawn from the evaluation performed to date by the CSN:

- The reports submitted by the licensees have been drawn up in accordance with the stress test specifications put together by WENRA/ENSREG and with a view to responding to the Complementary Technical Instructions (ITC) issued by the CSN. In keeping with the established schedule, these reports will be completed by the corresponding final reports, which the licensees are required to submit by October 31st next.

- In general, the descriptions and assessments submitted by the licensees are considered to be correct, taking into account the comments included in this report. Certain aspects have been identified in relation to which the information submitted should be completed in the final report.

- The design basis earthquake of each facility has been revised with the data on seismic activity occurring since the cut-off date considered in the original design and up to May 2011, using the methodology applied in the initial studies. As a result of this revision it is concluded that the value of the design basis earthquake adopted continues to be valid in all cases. In view of the progress made in the field of site seismic characterisation studies, the CSN is considering a programme to update these studies, in accordance with the most recent IAEA standards.

- The licensees are reviewing the analyses of the seismic margins, beyond the design basis, of the equipment allowing plant shutdown to be ensured and maintained. The review level earthquake used corresponds to a maximum horizontal acceleration of the ground of 0.3 g, a value that is between 1.5 and 3 times higher than the design basis earthquake, depending on the plant. In order to achieve this objective, certain structures and components presenting a lower margin should be reinforced.

  Certain plants are also going to perform additional seismic margins analyses for other components, among them the equipment foreseen to address a station blackout and severe accidents, as well as those that maintain the cooling of the spent fuel storage pool. These additional analyses should be considered by all the licensees in drawing up the final report.

  Taking these observations into account, the CSN considers the actions proposed to be adequate.

- All the plants have checked the suitability of the design basis with regard to off-site floods, including the hydrological and meteorological data recorded at each site throughout the operating period. From the evaluation it is concluded that the flooding levels adopted as the design basis continue to be valid at present. The CSN considers these results to be adequate.

The safety margins with respect to events that might lead to flooding levels above the design basis have also been analysed. The most critical events correspond to the potential rupturing of upstream dams. In all cases it has been seen that these dams withstand earthquakes larger than those adopted as the seismic design basis for each site. The licensees are performing specific analyses to quantify the seismic margins available at each dam. In addition, analyses of dams break for seismic reasons have been performed which have concluded that the flooding levels that would be reached at the plant would remain below the ground surface level. The CSN will review these analyses in detail.

The measures proposed to increase the safety margin of each site with respect to flooding are considered adequate, although in certain cases the information provided should be completed in the final report.

- As regards other natural external events, the licensees have carried out a specific re-assessment of the events considered in the original design or that might have an impact on safety at the site, using a probabilistic methodology. Events having a probability of occurrence of less than once every hundred thousand years were ruled out. The CSN considers these analyses to be adequate.

  With a view to determining safety margins beyond the design basis for the events that are credible at each site, and to consider possible reinforcement measures, the licensees should carry out additional analyses and include them in their final report.

- Of the scenarios contemplated in the analysis of loss of safety functions, that corresponding to the complete and long-lasting loss of alternating current electrical feed (on and off site) is the most limiting and bounds others, such as the complete loss of heat sink. The licensees propose measures to respond to this situation for the first 24 hours with equipment available at the facility, and for up to 72 hours with light equipment brought in from outside. As the most noteworthy aspect, measures are included to maintain d.c. feed to the controls and instrumentation necessary to maintain conditions of plant safety in such a situation. Also relevant are the measures to recover off-site power supply from nearby hydroelectric plants, with back-up from autonomous equipment. The CSN considers the approach presented to be adequate.

- All the nuclear power plant licensees have an organisation and measures for the management of accidents beyond the design basis, which will be reviewed and reinforced taking into account the lessons learned from the Fukushima accident. The licensees have agreed to set up a common support centre for all the plants, which will be equipped with human and material resources allowing it to intervene at any of the plants within a maximum 24 hours. The CSN considers that these proposals are adequate and that they will reinforce the capacities of the Spanish plants to respond to extreme situations, although the analyses and information submitted should be completed in the final report in relation to the sufficiency of the material and human resources available to address the different situations analysed.

- The licensees have strategies to respond to severe accidents in the reactor and the containment. These strategies are included in severe accident management manuals or guidelines, already evaluated and considered acceptable by the CSN.

The licensees identify a set of improvements in their reports. The most relevant of these are the installation of passive autocatalytic recombiners in those plants that do not already have such systems, the installation of different methods to inject water to the reactor vessel or containment, the performance of analyses for the installation of a filtered containment venting system and the verification of the suitability of the existing instrumentation. These measures are considered positive since they contribute to improving the capacity to maintain the core cooling and containment integrity functions and to reducing the release off site of radioactive substances in severe accident situations. In the final report the licensees should describe in detail the aforementioned improvements, along with any additional improvements not included in the progress reports, indicating their implementation plans.

Furthermore, the information submitted will be completed in the final reports with analysis of severe accidents under shutdown conditions, the possibility of accumulation of hydrogen in other buildings outside containment and the radiological conditions that might affect recovery actions at the plant.

- The licensees have analysed the spent fuel pool cooling systems and the existing strategies to respond to the loss of such cooling, as well as aspects relating to the loss of radiological shielding that would be implied by any reduction in the level of water in the pools. The reports submitted propose improvements to diversify the possibilities for water make-up and cooling of the spent fuel pool to address important accidents. The CSN considers the approach presented to be adequate, although the information submitted should be completed in the final report.